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May 31, 1990

Energy Research Abstracts

Abstracts 23258–25254

Office of Scientific and Technical Information
UNITED STATES DEPARTMENT OF ENERGY

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Energy Research Abstracts

Purpose

Energy Research Abstracts (ERA) provides abstracting and indexing coverage of all scientific and technical reports, journal articles, conference papers and proceedings, books, patents, theses, and monographs originated by the U.S. Department of Energy, its laboratories, energy centers and contractors. *ERA* also covers other energy information prepared *in report form* by federal and state government organizations, foreign governments, and domestic and foreign universities and research organizations. Foreign information is obtained through the International Energy Agency's 14-nation Energy Technology Data Exchange, the International Atomic Energy Agency's International Nuclear Information System, or nation-to-nation agreements. **Please note that *ERA* coverage of nonreport literature is limited to that generated by Department of Energy activity.**

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The citations presented in *ERA* are available for online searching as records within the Energy Data Base. The current-year records are available on the Integrated Technical Information System (ITIS). The entire database is available through commercial online vendors.

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Managing Editor, Audrey B. Smith
Technical Editor, Robert W. Rutkowski

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4. **Author(s).** First 10 names in the data record are printed, then "et al." is listed.
5. **Author affiliation.** Only first one is listed, in parentheses after author(s) to which it applies.
6. **Collaboration,** if present.
7. **Corporate author(s)** identifying corporation responsible for document.
8. **Patent assignee and number** for citations of patent documents or applications.
9. **Journal title, volume, and issue** for citations of journal articles.
10. **Date of publication.** If not known, a processing date is in brackets.
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17. **Secondary identifying number;** may be a conference number.
18. **Conference title, location, and date,** if applicable.
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21. **Drop note** or explanatory statement.
22. **Abstract.**
23. **Subject descriptors.** Listed only if no abstract or only a brief statement is included.

Sample Citations

Report

18494 (DOE/ER/40438–T1) **[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report.** Haeberli, W. Phys. VI collaboration. Wisconsin Univ., Madison (USA). Dept. of Physics. [1989]. 12p. Sponsored by DOE Energy Research. DOE Contract FG02-88ER40438. Order Number DE89007246. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper briefly discusses the Wisconsin test facility for storage cells; results of target tests; the new UHV...

Report Analytic

18500 (INIS-SU—69, pp. 30-32) **Transition energies in Ne-like ions. Correlation effects.** Vainshtejn, L.A. AN SSSR, Moscow. Fizicheskij Inst. 1988. (In Russian). In *Experimental and theoretical physics. Collection.* Order Number DE89780060. Available from NTIS (US Sales Only), PC A03/MF A01; INIS.

Kratkie Soobshcheniya po Fizike.; no. 6.

SILVER IONS/energy-level transitions; XENON IONS/energy-level transitions; CORRELATIONS; D STATES; E STATES;...

Journal Article

19055 **A theoretical and experimental investigation of long-pulse, electron-beam-produced rare gas plasmas.** Brake, M.L.; Repetti, T.E. (Energy Beam Interaction Lab. of the Dept. of Nuclear Engineering, Univ. of Michigan, Ann Arbor, MI (US)). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science (USA),* 16(5): 581-589 (Oct 1988). (CONF-881020–: Symposium on radiation physics, Sao Paulo, Brazil, October 3, 1988).

Visible emission spectroscopy (380-650 nm) has been performed on intense, electron beam (1 kA, 300 ns, 300 kV) produced Ar, Kr,...

Patent

18045 **Polarization of fast particle beams by collisional pumping.** Stearns, J.W. To Dept. of Energy, Washington, DC. USA Patent 4,724,117. 9 Feb 1988. Filed date 19 Oct 1984. vp. Available from Patent and Trademark Office, Box 9, Washington, DC 20232.

A method for polarizing a fast beam of particles by collisional pumping, comprising the steps of generating a beam...

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United Kingdom

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Five indexes are provided for approaching the content of each issue of *Energy Research Abstracts*. Descriptions of entries in these indexes follow.

Corporate Author Index
The corporation, organization, or institution responsible for the issuance of the document is listed in this index. The entries are arranged alphabetically and provide the title and citation number of the reference. For example, the listing for the "Report" sample citation would appear as shown at right.

Wisconsin Univ., Madison (USA). Dept. of Physics
[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)
Wisconsin Univ., Madison (USA). Lab. of Genetics
Organization of the R chromosome region in maize: Final progress report, June 1, 1983–May 31, 1986, 15:18255 (R;US)

Personal Author Index
Each author's name listed on a document cited in this issue is indexed. An index entry provides title and citation number; for secondary and other names, a cross-reference is given to the primary author name where the full index entry is located.

Hadley, D.L., *See* Lee, A.D., 15:17651
Haeberli, W., [Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)

Subject Index
This index lists the main subject descriptors assigned to each record by indexing professionals. A secondary or qualifier term is used where necessary to describe materials, objects, and processes. Document titles may be enhanced with additional informative phrases where necessary. An excerpt from this index appears at right.

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Neutron-Rich Isotopes
Study on the strong neutron-rich nuclei of lightest elements, 15:18686 (RA;SU;In Russian)

Contract Number Index
DOE technical reports are listed by contract number. Each entry also provides the primary corporation or organization cited for that contract number. A typical entry is shown.

FG02-88ER40438 **Wisconsin Univ., Madison (USA). Dept. of Physics**
15:18494 DOE/ER/40438–T1
FG02-88ER60664 **Rogers and Associates Engineering Corp., Salt Lake City, UT (USA)**
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Report Number Index
Technical report literature is indexed by the alphanumerical identifier of the report. Patent documents and conferences are included for convenience. Each entry lists the citation number, the source of availability of the document, an indicator of presence at a GPO depository library, order number, and distribution category. A typical entry is:

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Energy Research Abstracts

01 COAL, LIGNITE, AND PEAT

Refer also to citation(s) 23839, 24425

0103 Preparation

Refer also to citation(s) 23838

23258 (CONF-880770– III.177-III.190) **Fossil resins from coal - a wasted resource and target of opportunity.** Miller, J.D. (Univ. of Utah, Salt Lake City (USA)). Sheladia Associates, Inc., Rockville, MD (USA). Sep 1988. From Coal - targets of opportunity workshop; Washington, DC (USA); 12-13 Jul 1988. In *Coal: Targets of opportunity workshop: Proceedings.* Order Number DE89002076. Available from NTIS, PC A12/MF A01.

As a by-product from coal preparation, fossil resins have significant value (~$0.50/lb) as a special commodity in the ink, adhesive, rubber, varnish, coatings, and thermoplastic industries. In addition, this material has potential as feedstock for conversion to special high-density jet fuel. The fossil-resin content of western coals is significant (reaching several percent in some instances; consequently such coals have greater value for their resin content than for their traditional fuel content). Currently it is estimated that in Utah about 200 million pounds of resin are burned each year for power generation. This is a terrible waste of a natural resource and represents a viable target of opportunity. Efforts are being made to develop a technology base to support a fossil-resin industry. Of particular significance is the selective flotation of fossil resin from coal. This status of recovery technology is reviewed together with future research needs.

23259 (DOE/ER/13244–1) **Microwave enhanced high gradient magnetic desulfurization of coal.** Kelland, D.R. (Massachusetts Inst. of Tech., Cambridge, MA (USA). Francis Bitter National Magnet Lab.). Massachusetts Inst. of Tech., Cambridge, MA (USA). Francis Bitter National Magnet Lab.; General Electric Co., Schenectady, NY (USA). Corporate Research and Development Center. Oct 1988. 295p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER13244. Order Number DE90008597. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

This project consisted of several related lines of investigation, all leading toward the goal of improving the performance of high gradient magnetic separation (HGMS) in removing pyritic sulfur from eastern coals. The concept was to hear the pyrite included in coal, converting it to a more magnetic mineral form thus making more complete its removal by HGMS. The mechanism chosen was microwave irradiation. HGMS high magnetic fields and a high power microwave source was employed. We doubled the power density near the end of the project by halving the waveguide height. The magnetic properties of the coal minerals were studied by magnetometry and their chemical structure by Moessbauer spectroscopy, SEM and electron microprobe. Optical reflectance measurements, BTU and sulfur determinations were also made. We began with HGMS on whole coal samples: Upper Freeport, Pittsburgh and Illinois #6. Some were irradiated with microwaves up to 6 kW and others were retained as controls. We also measured the magnetization of pure mineral pyrite after direct contact heating. An extensive study of the microwave configuration in the waveguide was carried out at low power including the effect of having coal in the cavity. Finally, whole coal samples were subjected to microwave pretreatment in several atmospheres. In addition, a new technique of continuous axial HGMS was used to separate some constructed coal samples simply to demonstrate its possible application to improved coal desulfurization with magnetically enhanced coal pyrite. 108 refs., 160 figs., 12 tabs.

23260 (DOE/PETC/TR–89/9) **Interlaboratory comparison of advanced fine-coal beneficiation processes.** Jacobsen, P.S. (Burns and Roe Services Corp., Pittsburgh, PA (USA)); Killmeyer, R.P.; Hucko, R.E. USDOE Pittsburgh Energy Technology Center, PA (USA). Dec 1989. 12p. Sponsored by U.S. DOE Fossil Energy. (CONF-891130–3: 3. international conference on processing and utilization of high-sulphur coals, Ames, IA (USA), 14-18 Nov 1989). Order Number DE90007159. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Pittsburgh Energy Technology Center (PETC) recently completed three interlaboratory test programs involving 21 developers of advanced fine-coal-cleaning processes. The processes consisted of specific gravity separation (aqueous or heavy-liquid), electrostatic separation (dry), advanced froth flotation, selective agglomeration, and surface modification (gas). The participating organizations received representative samples of Illinois No. 6, Pittsburgh, and Upper Freeport bed coals. They ground them to a size appropriate for their particular process and then treated each coal. Their goal was to produce a clean coal with 2–3% ash while recovering maximum energy. The products were returned to the PETC for analysis and performance evaluation. This paper will discuss the processes involved in the three test programs and present the results of the beneficiation tests. 4 refs., 4 figs., 3 tabs.

23261 (ERP/CRL–87-135(J)) **Theoretical aspects of parallel coal processing circuits optimization and M-curve.** Salama, A.I.A. Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Coal Research Labs. Dec 1987. 26p. Available from Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Coal Research Labs.

This project investigates the problem of determining the optimum cutpoints of separation for processing different coals or different size ranges of a coal in parallel coal processing circuits which produce an overall product of maximum yield of mass flow rate at specified ash or sulphur level. Mayer curves are used to illustrate the results. 17 refs., 4 figs., 4 tabs.

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Refer also to citation(s) 23360, 23361, 23363, 23366, 23370, 23375, 23413, 23417, 23420, 23421, 23442, 23634, 23635, 23637, 23639, 23714, 23838, 23915, 23984, 24425

23262 (CONF-880770– III.87-III.98) **The conversion of coal to liquids and gases by advanced bioprocessing systems.** Scott, C.D. (Oak Ridge National Laboratory, TN (USA)); Faison, B.D. Sheladia Associates, Inc., Rockville, MD (USA). Sep 1988. From Coal - targets of opportunity workshop; Washington, DC (USA); 12-13 Jul 1988. In *Coal: Targets of opportunity workshop: Proceedings.* Order Number DE89002076. Available from NTIS, PC A12/MF A01.

A bioprocess can be defined as the directed and controlled use of living organisms or their products to bring about desired chemical and/or physical change. Because of their specificity, bioprocesses can be used to separate a product or contaminant from mixtures or to convert a component of a mixture to a useful product at mild operating conditions. There are an increasing number of concepts that are being considered for use in the processing of fossil fuels, particularly for coal. These include coal preparation technologies such as beneficiation; conversion of coal to useful liquid or gaseous products; product upgrading with removal of detrimental and hazardous components; and environmental control technology for gaseous, liquid, and solid effluents. The conversion of coal to liquids and gases is of specific interest, since the mild operating conditions of biological processes would be very attractive when compared to the rather severe chemical and physical process environment needed for the thermal/chemical conversion of coal. Research results on the biological conversion of coal are summarized and the potential impact of this evolving technology is assessed.

23263 (CONF-880770– III.121-III.141) **Advanced energy technologies at Combustion Engineering, Inc.** Gogineni, M.R. (Combustion Engineering, Inc., Windsor, CT (USA)); Andrus, H.E. Jr.; Turek, D.G.; Jones, T.J. Sheladia Associates, Inc., Rockville, MD (USA). Sep 1988. From Coal - targets of opportunity workshop; Washington, DC (USA); 12-13 Jul 1988. In *Coal: Targets of opportunity workshop: Proceedings.* Order Number DE89002076. Available from NTIS, PC A12/MF A01.

This paper describes ongoing activities at C-E relative to three technologies which may have an impact on the electrical power industry in the future: coal gasification, pressurized fluidized-bed combustion, and molten carbonate and solid oxide fuel cells. Each is capable of plant efficiencies which are significantly higher than conventional technology. Market penetration of these technologies in the future will depend on their ability to compete economically with current technology. Their market will depend on both fuel prices and technology improvements. C-E intends to remain involved in these areas to be in a position to supply systems as economic factors warrant.

23264 (CONF-880770– III.143-III.161) **Mild gasification of coal: Potential opportunities for value-added uses.** Sala, D.L. (Institute of Gas Technology, Chicago, IL (USA)); Babu, S.P.; Bair, W.G.; Wootten, J.M.; Duthie, R.G. Sheladia Associates, Inc., Rockville, MD (USA). Sep 1988. From Coal - targets of opportunity workshop; Washington, DC (USA); 12-13 Jul 1988. In *Coal: Targets of opportunity workshop: Proceedings.* Order Number DE89002076. Available from NTIS, PC A12/MF A01.

US DOE notes that the real opportunities for coal to displace oil exists in the light industrial, commercial, transportation, and large multifamily residential sectors. In addition, a coal conversion technology that is affordable in the present economic climate, which could be commercialized within the next 5 to 10 years will significantly benefit the nation and the coal industry. With these goals in mind, DOE is supporting R&D of mild gasification to produce coal-derived fuels and chemical feedstocks at a competitive price to displace petroleum derived products. Since the total investment requirement of these plants is on the order of 5-10% of the cost of the commercial-scale coal-to-gasoline or coal-to-pipeline quality natural gas projects proposed during the Carter Administration, project financing should be more-readily obtainable, at more-favorable terms. This paper describes mild gasification, then discusses the findings from a market survey of mild gasification co-products. These include char for utility fuel, form coke, smokeless domestic fuel or district heating fuel, adsorbent carbon, heavy creosote oil, carbon black, middle oils, and light oils. A preliminary economic analysis and commercialization plan are also described.

23265 (CONF-891081–) **Direct liquefaction contractors' review meeting: Proceedings.** USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. 320p. Sponsored by U.S. DOE Fossil Energy. From Direct liquefaction contractors' review meeting; Pittsburgh, PA (USA); 2-4 Oct 1989. Order Number DE90008423. Available from NTIS, PC A14/MF A01 - OSTI; GPO Dep.

Research programs, presented at the contractor's review meeting on direct liquefaction, are presented under the following topics: two-stage liquefaction; coprocessing; and advanced research on coal liquefaction. A total of 20 reports are included. Individual projects are processed separately for the data bases. (CBS)

23266 (CONF-891131–) **Indirect liquefaction.** USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. 475p. Sponsored by U.S. DOE Fossil Energy. From Indirect liquefaction contractors' review meeting; Pittsburgh, PA (USA); 13-15 Nov 1989. Order Number DE90008422. Available from NTIS, PC A20/MF A01 - OSTI; GPO Dep.

Research programs, presented at the contractor's review meeting on indirect liquefaction, are presented on the following topics: oxygenates (methanol) synthesis; Fischer-Tropsch synthesis; product upgrading; and process support engineering evaluations. A total of 18 reports are included. Individual projects are processed separately for the data bases. (CBS)

23267 (DOE/MC/21353–2793) **Gas separation applications to METC-supported technologies: Final report.** Poku, J.A.; Plunkett, J.E. EG and G Washington Analytical Services Center, Inc., Morgantown, WV (USA). Dec 1989. 95p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-85MC21353. Order Number DE90000440. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The objectives of this study were to catalog both hot and cold gas separation technologies, to identify the status and the developers of each, and to identify how these separation processes might be applied to METC-supported technologies for removal of trace contaminants, or purification of gases used in or generated by coal processing. Discussions on gas separation process names, typical feeds, process developers, and operating conditions are provided in the following sections of this report, as well as descriptions of how these gas cleanup techniques would be used in developmental coal conversion technologies. 82 refs., 22 figs., 14 tabs.

23268 (DOE/METC–88/6092-Vol.1, pp. 1-10) **The Appalachian project.** USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The objective of The Appalachian Project (an advanced design, integrated, combined cycle (IGCC) power plant) is to demonstrate an efficient, economical and environmentally superior method of generating electric power from coal. Because The Appalachian Project uses hot gas cleanup it is expected to demonstrate lower capital, operating, and electricity costs than other modes of power generation, and it is expected to be the forerunner of many power generation projects in the 1990's. The project will integrate a number of technologies, as follows: Kellogg's KRW fluidized bed gasifier; In-bed desulfurization using limestone sorbent; External bed desulfurization, using zinc ferrite; Hot particulate removal; Sulfation processing; and Combined cycle power generation/waste heat recovery. These topics are addressed in this paper.

23269 (DOE/METC–88/6092-Vol.1, pp. 11-20) **Integrated operation of a pressurized fixed-bed gasifier and hot gas desulfurization system.** Gal, E. (GE Environmental Systems, Lebanon, PA (USA)); Furman, A.H.; Ayala, R. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The overall objective of the project is to demonstrate successful operation of a novel, moving bed, hot fuel gas desulfurization system, integrated with the GE air-blown, fixed-bed, coal gasifier in Schenectady, New York. The demonstration will utilize the full flow from the one-ton-per-hour gasifier operating at 300 psig with an outlet temperature of 1050 - 1150 F. An advanced formulation of zinc ferrite, designed to preserve sulfur reactivity and regenerability while significantly improving mechanical durability, will be evaluated in large scale, hot, long term operation. When demonstrated, this gasifier/hot gas cleanup configuration will provide a key building block element for advanced integrated gasification, gas turbine power generation systems. The background, project description, accomplishments to date, and future work are described.

23270 (DOE/METC–88/6092-Vol.1, pp. 21-31) **Integration and testing of hot desulfurization and entrained flow gasification for power generation systems.** Robin, A.M. (Texaco Inc., Montebello, CA (USA)); Wu, J.C.; Najjar, M.S. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The primary objective of this program is to demonstrate, on a pilot plant scale, an improved integrated coal gasification combined cycle (IGCC) electric power generation system utilizing hot gas cleanup and the commercially proven Texaco Coal Gasification

Process. New specialized instrumentation, developed for coal gasification, also will be tested during this program. The preliminary desulfurization research during the first year of the program will consist of four tasks as follows: Theoretical Studies, Bench Scale Tests, PDU Scoping Tests, and Advanced Instrumentation Evaluation, all of which are described. The test program for the first year includes a one-day shake-down run and three three-day scoping runs, all with pure oxygen as the oxidant. Washed Pittsburgh No. 8 coal (2.1% S) will be used for most of the tests. However, tests of a higher sulfur bituminous coal are also planned. Several on-line analytical instruments currently under development at METC have been selected for testing. During the first year, only the continuous alkali monitor will be available. This instrument will be set up to analyze the syngas at the top of the radiant syngas cooler. Accomplishments to date are described.

23271 (DOE/METC–88/6092-Vol.1, pp. 32-44) **Fluidized bed coal gasification with hot gas cleanup.** Haldipur, G.B. (KRW Energy Systems Inc., Madison, PA (USA)); Smith, K.J.; Datta, S.; Cherish, P. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The overall goal of the program is to provide an engineering design data base for an Integrated Gasification Combined Cycle (IGCC) technology, which is comprised of a pressurized fluid-bed gasifier with in-bed desulfurization, an external polishing desulfurizer using a regenerable metal oxide sorbent, and appropriate particulate cleanup regenerable metal oxide sorbent, and appropriate particulate cleanup trains for turbine protection and control of environmental emissions. Specific objectives of the technology development program are to: (1) characterize the operation performance of a 15 tpd pilot-scale gasifier with in-bed desulfurization, (2) demonstrate hot gas particulate cleanup using cyclones and barrier filters, and (3) develop pilot-scale operability data on a fixed-bed external desulfurizer using a zinc ferrite sorbent. After a brief description of the background and project, results on the following are described: gasifier and in-bed desulfurizer; recycle cyclones; non-recycle high-efficiency cyclone; ceramic candle filter system; external desulfurizer; operation with dust-laden gas; operation with filtered gas; and fuel gas conditioning effects.

23272 (DOE/METC–88/6092-Vol.1, pp. 45-57) **Copper-based sorbents for hot gas cleanup.** Jalan, V (ElectroChem, Inc., Woburn, MA (USA)); Desai, M. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The objective of the Phase I research was to establish the feasibility of incorporating copper manganese oxide based sorbents into the Morgantown Energy Technology Center (METC) high temperature regenerable desulfurization process. To meet this objective, a successful sorbent would have to demonstrate high desulfurization capacity, high reactivity (defined as sulfur removal to less than one part per million), efficient and complete regeneration over numerous cycles without loss of surface area or pore structure, the potential for effective integration with coal gas fueled electrical power generation systems (such as the Integrated Gasifier Combined Cycle power plant), and a significant cost advantage over the most promising sorbent systems studied to date. Experimentally, candidate sorbents were prepared and evaluated for reactivity, capacity, and regenerability. Sorbent systems identified by DOE/METC were tested for comparison. Results are discussed.

23273 (DOE/METC–88/6092-Vol.1, pp. 58-82) **Sidestream zinc ferrite regeneration tests: Laboratory-scale study of reductive regeneration of zinc ferrite sorbents.** Grindley, T. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

In the course of the development of regenerable, zinc-based sorbents for the desulfurization of the hot gas derived from coal gasification, it has become evident that oxidatively regenerated sorbents inevitably contain a considerable amount of residual sulfur in the form of zinc sulfate. This zinc sulfate tends to decompose in the initial stages of absorption when the oxidatively regenerated sorbent is brought back on-line. Until the regenerated sorbent is in its reduced form, the decomposing sulfate releases a high concentration of sulfur species, including SO_2, H_2S, and COS, into the gas stream. This undesirable result can be avoided by reducing the oxidatively regenerated sorbent in a reductive regeneration step so that the sorbent can be returned to service in its reduced form. It is proposed that the reductive regeneration be achieved either by recycling hot clean gas or passing partially combusted natural gas through the sorbent until it is reduced. The tail gas from the process may be injected into the gasifier or upstream of the on-line absorber. In order to establish the most suitable conditions for reductive regeneration, METC conducted an experimental study of the reduction of a zinc ferrite sorbent which had been oxidatively regenerated under pressure in a process development unit. Experimental procedures are described and results are tabulated and discussed.

23274 (DOE/METC–88/6092-Vol.1, pp. 83-92) **Enhanced durability and reactivity for zinc ferrite desulfurization sorbent.** Berggren, M.H. (AMAX Research and Development Center, Golden, CO (USA)); Harrison, D.P. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The prime objective of this project is to identify and investigate methods for enhancing the durability and reactivity of the zinc ferrite desulfurization sorbent. The objective is being accomplished by preparing a large number of sorbent samples representing modified chemical compositions and different preparation and induration procedures. Selected samples which meet the requirements of the physical characteristics are being used in cyclic sulfidation/regeneration tests to determine their reactivity. These sorbent samples are being characterized before and after cyclic testing to determine their durability. The resulting data are being analyzed to categorize the sorbents and to establish the chemical composition and preparation procedures that will result in the most reactive and durable sorbent. Results from sorbent preparation, bench-scale testing, and bench-scale test analysis are presented and discussed.

23275 (DOE/METC–88/6092-Vol.1, pp. 93-102) **Dynamic simulation models for high-temperature desulfurization processes-II.** Wang, J. (Louisiana State Univ., Baton Rouge (USA)); Cockrill, D.; Groves, F.R. Jr.; Harrison, D.P. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

Four models have been developed. Separate models describe sulfidation and regeneration in the fixed-bed reactor because different numerical solution techniques are required for each. A single model describes both the sulfidation and regeneration cycles in the fluidized- and moving-beds. Page limitations preclude mathematical development in this paper. Instead, the models are described qualitatively, input parameter requirements are defined, and example results presented.

23276 (DOE/METC–88/6092-Vol.1, pp. 103-113) **Bench-scale testing of novel high-temperature desulfurization sorbents.** Harkins, S.M. (Research Triangle Institute, Research Triangle Park, NC (USA)); Gangwal, S.K. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV

(USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The objectives of this contract are to perform bench-scale evaluation and preliminary engineering/economic assessment of novel high-temperature desulfurization sorbents which have shown potential for high-efficiency hydrogen sulfide removal down to 1 ppmv and/or stable operation at sulfidation temperatures greater than 1200F. Four of these sorbents and their abbreviated designations are: $(ZnO)_{0.86}(CuO)_{0.14}Fe_2O_3$ (ZC)F; $(ZnO)_{0.8}(TiO_2)$ (0.8Z)T; (3CuO) (Fe_2O_3) (Al_2O_3) (C3)FA; and (CuO) (Al_2O_3) CA. The highlights of results to date are as follows: The (0.8Z)T sorbent exhibited excellent durability over 5 cycles at 1350F, was significantly simpler to regenerate than other sorbents, and underwent very little sulfation during oxidative regeneration. The (ZC)F sorbent adsorbed an average of up to 15% sulfur by weight and was capable of reducing the H_2S to less than 1 ppmv over two cycles at 1100F. The (C3)FA sorbent was capable of reducing the H_2S to less than 0.2 ppmv during the first sulfidation. Performance deteriorated during subsequent sulfidations, presumably because of incomplete regeneration. Disadvantages of the CA and (C3)FA sorbents include severe exothermicity due to CuO reduction, poor regenerability due to excessive sulfation, and significant loss of strength due to sulfate formation and decomposition. The CA sorbent also had a low average sulfur capacity.

23277 (DOE/METC–88/6092-Vol.1, pp. 114-123) **Study of ammonia removal in coal gasification processes.** Krishnan, G.N. (SRI International, Menlo Park, CA (USA)); Wood, B.J.; McCarty, J.G. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The objective of this program is to identify and study a most promising process concept that can eliminate 90% of fuel-bound nitrogen from coal gas in a temperature range of 550 to 900C. Ammonia is the major gaseous product of fuel-bound nitrogen produced by gasification of bituminous coals. The program is divided into three tasks: Comprehensive review of the literature (completed); Development of an experimental test plan (completed); Catalyst testing (in progress). Several catalysts were selected for experimental testing under laboratory-scale conditions. The selection criteria included high catalytic activity, tolerance to sulfur poisoning, resistance to degradation under high steam concentrations, and physical stability. The selected catalysts include: Ni-based catalysts on a proprietary ceramic support; Ni-based catalysts with CaO-stabilized alumina as the support; Zinc ferrite sorbents that contained NiO and CuO additives; and a MoS_2-based methanation catalyst. Results to date are discussed.

23278 (DOE/METC–88/6092-Vol.1, pp. 124-133) **Ammonia removal in coal gasification processes using integrated systems approach.** Unnasch, S. (Acurex Corporation, Mountain View, CA (USA)); Chang, R. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The purpose of this project was to investigate process concepts to eliminate NO_x formation from fuel-bound nitrogen, primarily ammonia, in the gas stream from a coal gasifier at 1000 to 1600F; to review all previous experimentation; and, to test the most promising approach to reduce the formation of NO_x to achieve environmentally acceptable levels. Staged combustion was tested under simulated hot coal gas conditions. Catalytic dissociation was also tested as an ammonia removal approach for comparison to staging. The results of this program have demonstrated the effectiveness of staged combustion in controlling NO_x emissions from gasifier gases containing ammonia. Staged combustion produced a minimum NO_x level of 50 ppm (corrected to 15% O_2) at about 70% theoretical air for the fixed-bed gas and 50 ppm at 50% theoretical air for the entrained-bed gas. Ammonia conversion to NO_x was less than 5% at the minimum NO_x condition. With both gas compositions, NO_x emissions asymptotically leveled off at high inlet ammonia levels. Upstream ammonia removal systems may not be needed to meet environmental constraints. At ammonia levels above 100 to 2000 ppm, emissions with staging reached asymptotic levels, so additional upstream removal would be minimally effective. Catalytic dissociation can augment NO_x reductions from staged combustion and reduce combustor volumes for a given emissions target.

23279 (DOE/METC–88/6092-Vol.1, pp. 134-142) **Modeling hydrodynamic mixing in process design and development of fluidized bed gasifiers.** Blake, T.R. (Univ. of Massachusetts, Amherst (USA)). USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

In this project, models for hydrodynamic mixing in fluidized beds are used in a representative process design and development scenario for the KRW gasifier. The particular emphasis in this study is upon the use of two modeling approached: the dimensional analysis and scaling of fluidization data, and the finite difference hydrodynamic model CHEMFLUB. Predictions of hydrodynamic mixing in the KRW reactor are made. Further, the relative value and practicality of the two different models for predicting hydrodynamic mixing is to be assessed. Present results include: (1) A demonstration that the bubble velocity data and the jet penetration data from the KRW 3 m diameter cold flow rig, and the jet penetration data from the Westinghouse 30 cm diameter cold flow rig are well represented by existing correlations. (2) An application of CHEMFLUB simulated fluidization in the KRW 3 m diameter cold flow rig, and in the Westinghouse 30 cm diameter cold flow rig. For a specific choice of shape factor, which is different for the respective bed particles, the calculations provide accurate predictions of several aspects fluidization: jet penetration height, bubble velocity, and bubble frequency. (3) A relatively comparison of the correlations and CHEMFLUB on the prediction of jet penetration height, bubble motion, and characteristic frequency, suggest relative strengths and weaknesses of the two modeling techniques.

23280 (DOE/METC–88/6092-Vol.1, pp. 143-157) **Advanced gasification entrained reactor.** Bissett, L.A. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The objectives of this study are to: determine the effects of coal gasification environment on product yields over broad range of reaction conditions; and advance the understanding, development, and modeling of gasification technology. The reactor has broad operational capabilities and is uniquely characterized by a gas-solid mixing section which, in combination with highly preheated gases, results in high particle heating rates. A test program employing a statistical experimental design has been completed with a subbituminous coal and is underway with a bituminous coal. This approach has enabled the use of regression modeling and statistical analyses of the test data. Experimental trends identified by this approach are being compared to predictions from the PCGC-2 computer code and will hopefully lead to code improvements. The code is also being used to estimate experimental gas and particle residence times. Results to date are given.

23281 (DOE/METC–88/6092-Vol.1, pp. 177-180) **Experimental development of a multi-solid fluidized-bed reactor concept.** Paisley, M.A. (Battelle Columbus Division, Columbus, OH (USA)). USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The objective of the proposed experimental program is to prove the feasibility and quantify the performance of the MSFB gasification system. Development of this advanced coal gasification system is directed toward meeting the needs of the utility industry for an economical, environmentally acceptable and flexible technology. A series of progressive experiments are planned to provide performance data to be used in a process technical and economic evaluation. Coal is fed into a MSFB gasifier which operates at 10 to 30 feet per second superficial velocity. The product gas is separated from circulating solids in a cyclone and then goes to product gas cleanup. The circulating solids go the a MSFB combustor which burns the unreacted char to provide heat for the gasifier. Circulating solids are returned to the gasifier to control temperature and heat balance between the two vessels. The combustor flue gas goes to a heat recovery system without diluting the product gas. Therefore, air can be used in the combustor with significant savings over systems which require oxygen and/or dilute the product gas stream. Fuel flexibility is provided by the turbulent mixing in the MSFB dense bed. Coal particle sizes ranging from 2-inch including fines can be fed into the MSFB reducing rejected material and fuel preparation costs. Reduced ash agglomeration problems result from the turbulent mixing in the dense bed. Results to date are discussed.

23282 (DOE/METC–88/6092-Vol.1, pp. 181-186) **Reaction kinetics and simulation models for novel high-temperature desulfurization sorbents.** Woods, M.C. (Research Triangle Institute, Research Triangle Park, NC (USA)); Harrison, D.P.; Groves, F.R.; Jothimurugesan, K. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The objectives of this project are to investigate single pellet reaction kinetics of zinc ferrite and zinc titanate using a thermogravimetric reactor (TGR) at typical gasifier outlet conditions (1000 - 1400F and 1-20 atmospheres) and to develop single pellet kinetic models based on the data. Contract options call for integral reactor models to be developed from the single pellet models. To date, the following items have been accomplished. Both the RTI and LUS TGR's have been modified to allow for additional pellets in the reactor tube besides the single pellet suspended from the hangdown wire. Both systems have been commissioned and sulfidation equivalency has been established between the two systems. Zinc vaporization and initial sulfidation tests have been completed on each of the four zinc titanate formulations and 1.5 $ZnO \cdot TiO_2$ has been selected for a detailed kinetic study. The pressure, temperature, and H_2S concentration dependencies of zinc ferrite (T-2465) sulfidation kinetics were measured using a KRW simulated gasifier gas. The intrinsic reaction activation energy and pseudo-rate constant were obtained for zinc ferrite (T-2465) sulfidation. All available results are discussed.

23283 (DOE/METC–88/6092-Vol.1, pp. 187-198) **Side stream hot gas cleanup.** Lee, G.T. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The objectives of this study are to investigate process fundamentals of solid sorbents/reactants on the removal of contaminants from a sidestream of actual coal-derived gas and optimize contaminant removal efficiency for sulfur species, tar, ammonia, and chlorides. Zinc ferrite, currently the prime candidate sorbent for hot gas desulfurization, has been extensively tested at METC in laboratory-scale and side stream units. The side stream unit serves as an intermediate or screening facility to confirm the results of laboratory-scale experiments and to provide data for scaleup. Most of the laboratory-scale experiments were carried out at low pressures using simulated gas, while the side stream testing emphasizes the use of real gas for the investigation of process fundamentals of solid sorbents on the removal of contaminants at actual operating conditions. The two-reactor system consists of two major reactors: a fluidized-bed and a fixed-bed reactor which allows testing of sorbent capabilities in two different contact modes in a parallel arrangement. It allows testing of absorption of different materials in a series configuration. Accomplishments to date (fabrication) are described.

23284 (DOE/METC–88/6092-Vol.1, pp. 199-203) **Development of a hot gas clean-up system.** Anderson, G.L. (Institute of Gas Technology, Chicago, IL (USA)); Hill, A.H. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The overall objective of this project is to develop sorbents for removing sulfur-containing compounds and HCl from hot coal-derived fuel gas to less than 1 ppm(v) at operating temperatures between 1000 and 1200F. These sorbents could be applicable to cleanup of fuel gases in both integrated coal gasification/molten carbonate fuel cell power plants and integrated coal gasification/combined-cycle power plants. The project includes five tasks in addition to program planning and final report preparation: (1) laboratory-scale studies to optimize the concentration of cobalt titanate in one of the sorbents used in the mixed metal oxide process; develop an oxygen-regenerable zinc oxide/zinc aluminate sorbent for the process; and explore the use of less costly molten carbonate mixtures in the IGT hot HCl removal sorbent, (2) design and construction of a skid-mounted 3000-SCF/h bench-scale hot gas cleanup process test system, (3) shipping the test system to METC for testing there, and (4) performing an engineering and economic assessment of the processes. Results to date are presented.

23285 (DOE/METC–88/6092-Vol.1, pp. 204-214) **Pore structure and reactivity changes in hot coal gas desulfurization sorbents.** Sotirchos, S.V. (Univ. of Rochester, NY (USA)). USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

During the past period, efforts have been concentrated on the development of a detailed simulation model for hot coal gas desulfurization in a fixed-bed reactor packed with pellets of metal oxide sorbents. Various structural models of distributed pore or grain size developed by this research group for studying gas-solid reactions with solid product have been modified for application to metal oxide sulfidation. These models have been used to develop a detailed simulation model that can be used to study the transient phenomena that take place during desulfurization of coal gas in fixed-bed reactors loaded with pellets of metal oxide sorbents. The desulfurization model was applied to the analysis of the transient behavior of fixed-bed reactors loaded with pellets of zinc oxide. Particular emphasis was placed on the investigation of the effects of the structural model used for representation of the pore structure of the pellets, as well as of the effects of the structural characteristics of the porous solid (internal surface area, porosity, and pore size distribution), on the breakthrough behavior of the reactor and, hence, on the utilization of the sorbent. The developed desulfurization model is outlined, and some of the results obtained for fixed beds of zinc oxide pellets are presented and discussed.

23286 (DOE/METC–88/6092-Vol.1, pp. 215-219) **Subpilot scale gasifier evaluation of ceramic cross-flow filter.** Lippert, T.E. (Westinghouse R and D Center, Pittsburgh, PA (USA)); Bachovchin, D.M.; Smeltzer, E.E.; Robin, A.M. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The overall objective of this project is to verify the suitability of ceramic cross-flow filter technology for use in a coal gasification environment. Westinghouse is designing a system, containing several full-scale (12x12x4 inch) filter elements, that will be tested at the Texaco Coal Gasification Pilot Plant in Montebello, California. Specific goals of the program include: demonstrate successful operation of the full-scale ceramic cross-flow filter element in the gasification environment; identify and resolve any mechanical or operational concerns introduced by the gasification conditions; develop concise system related design procedures for use in scale-up and design; and develop the operating and installed costs of the filter concept, and relate to effects on the overall process and on emissions. The study is in its earlier stages, so no results are available.

23287 (DOE/METC–88/6092-Vol.1, pp. 220-223) **Long-term durability testing of ceramic cross-flow filter.** Smeltzer, E.E. (Westinghouse Electric Corporation, Pittsburgh, PA (USA)); Bachovchin, D.M. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The objective of this work is to assess the long-term mechanical integrity and chemical stability of components and materials used in construction of the ceramic cross-flow filter by conducting long-term durability tests under simulated PFBC and reducing gas conditions, with fly ash and char. A second objective will be to compile a comprehensive commercialization study encompassing surveys of market sector, demand, and estimates of unit production cost and selling price. Experimental procedures, including test conditions for both the reducing gas and PFBC simulators, are described. Since the study is in its earlier stages, no results are available, but the status of preliminary work is described.

23288 (DOE/METC–88/6092-Vol.1, pp. 233-239) **Sulfur kinetics studies.** Anderson, R.J.; Pham, H.; Grimm, U. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The objective of this study is to determine the potential role of calcium-based sorbents in controlling release of sulfur from a number of both gasification and combustion systems. The research tasks involve surface science studies of the mechanisms and rates of the sulfur/calcium reactions, studies of sorbent preparation and characterization, laboratory-scale studies of sulfidation for both fixed-bed and entrained-flow reactors, correlations of laboratory-scale and pilot-scale data, models of the reactors and sulfidation reactions, and studies of the formation of stable, disposable sulfur products. One aspect of the study has led to the development of a computer code which combines thermodynamic equilibrium and a one-dimensional gasifier model to describe METC's 42-inch stirred, fixed-bed gasifier. This code has been used to qualitatively predict the distribution of sulfur species throughout the gasifier which has limestone added to the coal feed at a calcium to sulfur ratio of 2. Preliminary calculations using the code indicate that conditions may exist in the gasifier which cause decomposition in the combustion zone of the sulfur captured by the sorbent in the upper portions of the gasifier. In addition, the model correctly predicts that some of the sorbent may react with the mineral components of the ash to form calcium-alumino-silicate compounds which do not effectively react with sulfur. Another part of the study involves the collection of experimental data on sorbent utilization and reaction rate for conditions which simulate fossil energy processes. Tests have been initiated on an existing pressurized laboratory-scale entrained reactor which is capable of pressures up to 175 psig and temperatures up to 2700F under either oxidizing or reducing conditions.

23289 (DOE/METC–88/6092-Vol.1, pp. 247-262) **Novel concepts of system assessment in coal gasification.** Shinnar, R. (CUNY Research Foundation of New York, NY (USA)). USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The objective of this task is to assess the impact of the end use and total system design on the economically desirable operating conditions and design properties of gasifiers. It is also intended to investigate novel system configurations that will improve the performance and cost of the total system, and inquire what gasifier properties lead to better overall system properties. Two related problem areas were chosen for this study, which are: (A) Assessment of gasifier requirements for generation of electricity from coal in combined cycle power plants that have (1) very low emissions and acceptable disposable solids (2) high thermal efficiency (3) lower investment costs and suitability for modular construction (4) the ability to produce liquid hydrocarbons by mild gasification. Special emphasis will be given to study the applicability of fluid bed gasifiers and in particular airblown fluid bed gasifiers for this purpose. (B) Study the potential of a slagging and a fluid bed gasifier for hydrogen production with the coproduction of methane and mild gasification products. Assess the impact of novel separation processes on the overall cost and performance of such a system as well as on conventional hydrogen plants from coal. Results are discussed on the following: comparison of oxygen blown versus airblown gasifiers; impact of limestone addition; impact of air-to-coal ratio; recycle of product gas to feed coal; quenching the product gas; penalty of pressure reduction in turbine feed valve; and control of the gasifier.

23290 (DOE/METC–88/6092-Vol.1, pp. 263-269) **Calderon coal gasification process development unit design and test program.** Campbell, K. (Calderon Energy Company, Bowling Green, OH (USA)); Polen, K.; Calderon, A. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The process development unit (PDU) is designed to demonstrate the Calderon gasification process. In the process, run-of-mine high sulfur coal is first pyrolyzed to recover a rich gas (medium Btu gas), after which the resulting char is subjected to airblown gasification to yield a lean gas (low Btu gas). The process incorporates an integrated system of hot gas cleanup which removes both particulate and sulfur components of the gas products, and which cracks the rich gas to yield a syngas (CO and H_2 mix) suitable for further conversion (e.g., to methanol). The lean gas is suitable to fuel the combustion turbine of a combined cycle power generation plant. The PDU is sized to process 1 ton per hour of a high sulfur midwestern coal typical of that produced by Ohio mines. The rich and lean gas will be produced separately for the demonstration but will be combined during the test for disposal by flaring. The construction of the PDU will take place on property of Alliance Machine Co. in Alliance, Ohio.

23291 (DOE/METC–88/6092-Vol.1, pp. 270-288) **Sulfur capture in a fixed-bed gasifier.** Bissett, L.A.; Reuther, R.B.; Strickland, L.D. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

Integrated Gasification Combined Cycle (IGCC) systems with hot gas cleanup are emerging as an important alternative technology for power generation. Studies with fixed-bed gasifiers coupled with zinc ferrite or certain other metal oxides for desulfurization are particularly simple and promising systems for power generation in achieving this goal. The sulfur dioxide created during the regeneration of the metal oxide sorbent must be converted into a usable or disposable form. One possible process scheme to accomplish this is to recycle the regeneration offgas stream to the gasifier where the sulfur dioxide can be captured as calcium sulfate and removed

in the ash. This paper reports on recent tests associated with the development of this process scheme. Results from tests at the Morgantown Energy Technology Center in which sulfur dioxide was injected into the bottom of a fixed-bed gasifier show that significant capture of sulfur in the ash is possible when calcium-based sorbents are added with the coal. The capacity of the gasifier to fix sulfur in the ash must surpass a minimum level, which varies with operating parameters, in order for the integrated system to work. Also, the details of the zinc ferrite regeneration operation can have a significant impact upon the viability of the integrated process. Test results and their impact on the operation of an integrated system are discussed.

23292 (DOE/METC–88/6092-Vol.1, pp. 289-303) **Gas cleanup systems analysis.** Craig, K.R.; Koch, R.W. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

Removal of contaminants and pollutant precursors from high temperature, high pressure (HTHP) coal-derived gas streams is critical to the realization of the full potential of emerging coal technologies. The objective of the gas cleanup systems analysis effort at the Morgantown Energy Technology Center (METC) is to identify, evaluate, and quantify the technical and economic benefits of evolving HTHP cleanup and other separation technologies. Previous systems and cost analyses have shown that commercially available technologies (gasifiers and gas turbines) can provide significantly efficiency improvements and cost of electricity (COE) reductions for integrated gasification combined-cycle (IGCC) power production systems. Revised analyses based on emerging technologies show that HTHP contaminant removal processes have the potential to improve previously noted system cost and performance benefits. Developing technologies hold promise for even further process simplification (combining several contaminant removal steps in one unit) and efficiency gains. Quantified evaluations of these benefits are presented. Also presented are preliminary results from the investigation of advanced separation technologies as applied to non-power generation systems.

23293 (DOE/METC–88/6092-Vol.1, pp. 309-323) **Design basis for zinc ferrite hot gas desulfurization systems.** Kasper, S. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

Morgantown Energy Technology Center (METC) and its contractors have been conducting a series of tests with zinc ferrite to determine its ability to remove hydrogen sulfide from coal-derived gases at elevated temperatures. Many properties such as capacity, reactivity, durability, and others have been measured over an extended period and through numerous cycles of operation. The ultimate objective is to establish the data needed for the design of a reliable and economical commercial-scale hot gas cleanup system. At this stage of development, enough data exist to permit the design of a fixed-bed zinc ferrite desulfurization system with predictable performance characteristics. Recommended values for design are: Space Velocity - 2000/Hour; Superficial Velocity - 2 Feet/Second Maximum; Sulfidation Temperature - 1200F Maximum; Regenerant Gas - Steam/Air for Oxidation Phase; Regeneration Bed Temperature, 1450F Maximum; Sulfate Formation - 3%; Sorbent Capacity - Initial, 32%; Long Term (> 40 Cycles), 10%; Sorbent Attrition - .0022 Weight Fraction/Cycle, or .22%/Cycle. A preferred configuration includes in-bed desulferization in the gasifier and recycle of spent regeneration gas to the gasifier. Ninety percent sulfur removal is selected as being achievable in fluidized-bed gasifiers. Clean product gas is used as reductive regenerant and is recycled to the gasifier. The basis of design presented is suitable for conceptual design of commercial-scale facilities or a guide for detailed process design of test-scale facilities.

23294 (DOE/METC–88/6092-Vol.1, pp. 324-332) **Zirconia cell oxygen source.** Suitor, J.W. (Jet Propulsion Laboratory, Pasadena, CA (USA)); Marner, W.J.; Schroeder, J.E. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The project sponsored by DOE is a five year effort leading to the operation of a 100 liter/min oxygen production unit. During this time an industrial partner will be located to whom the technology will be transferred. The oxygen production unit will consist of a zirconia module for oxygen separation and the ancillary equipment arranged as an oxygen production plant. The zirconia module operates on the principle of electrodialysis. Accomplishments previous to this year are listed after a description of the plant and its concept. The current fiscal year has continued work on Tasks 4 (plant design) and 5 (subsystem components) with emphasis on: distribution plate development, interfacial resistance reduction, stack design and testing, and zirconia disk manufacturing cost estimates. Results of the current year are discussed.

23295 (DOE/METC–88/6092-Vol.1, pp. 351-369) **Gasification ash and slag characterization.** Kalmanovitch, D.P. (Univ. of North Dakota, Grand Forks (USA)). USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The overall objective of this project is to develop a unified picture of the ash formation and its behavior in coal gasification systems. In particular the project aims to provide data on the behavior of ash and how it affects gasifier operation. The project is divided into four tasks. The first task involves the characterization and identification of mechanisms responsible for the complex mineral transformations that coal minerals exhibit under gasification systems. The second task involves the study of vaporization of inorganic constituents during gasification processes. The third task evaluates slag viscosity behavior under reducing conditions. The fourth task involves the determination and subsequent modeling of surface tension of coal ashes. Background, the project description, and results to date for all four tasks are given.

23296 (DOE/METC–88/6092-Vol.1, pp. 370-380) **Performance evaluation of a screenless (counter-current) granular bed filter on a subpilot-scale PFBC [pressurized fluidized bed combustor].** Haas, J. (Combustion Power Company, Menlo Park, CA (USA)); Cooper, J.; Wilson, K. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The objective of this investigation are: (1) to augment information on the feasibility of a Granular Bed Filter (GBF) for controlling particulate in a Pressurized Fluidized-Bed Combustor (PFBC) power generating system, (2) to assess the design and life of critical components in the filter system, and (3) to estimate costs of a commercial-scale design based on tested concepts. The paper describes granular bed filter equipment for New York University testing, the pressurized fluidized - bed combustion test equipment, and preliminary test results.

23297 (DOE/METC–88/6092-Vol.1, pp. 381-385) **Development of a novel nested-fiber filter concept for high-temperature and high-pressure physical cleanup.** Conkle, R.D. (Battelle Columbus Division, Columbus, OH (USA)). USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup*

systems contractors review meeting: Volume 1. Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The project objective is to develop a gas-filtration system capable of operating at high temperatures and pressure (HTHP) for use in IGCC and PFBC applications. The Nested Fiber Filter (NFF) system is based on the concept of a nest of needle-like fibers made from an alloy suited for the application. Filter action results from particulate matter forming dendritic, or chain-like, structures on the surface of the fibers. The test results showed that face velocity was the most significant filter parameter. The tests showed that a 180- to 250-mm bed of 13-mm-long fibers operated at 0.5 to 1 m/s face velocity with < 44-μm flyash resulted in collection efficiencies ranging from 99.0 to 99.9% with 200- to 300-mm-water pressure drop. Size analysis of the flyash leaving the NFF indicates that all material was smaller than 3 μm in diameter. Elevated pressure, over a range of 1 to 6 atmospheres absolute, showed no statistically significant effect on capture efficiency. Pressure drop, however, increased as the pressure was raised due to the increased density of the gas. A series of high-temperature tests evaluated the NFF performance up to 1570 F. These tests confirm the expectation that outstanding particulate capture is maintained at high face velocity and low-pressure drop. Flyash known to have a small average particles size (4.6 μm) was used to test collection efficiency. The AFBC ash used for most of the tests had a mean size of 6.2 μm and a broader size distribution. The NFF collection efficiency was excellent with the finer particulate. Three techniques have been tested for cleaning/regenerating the NFF: rotation, vibration, and pulse-jet flow. Vibration is the most effective cleaning technique for the present test modules. Cleaning will be evaluated further as part of the Mechanical Development effort.

23298 (DOE/METC–88/6092-Vol.1, pp. 386-395) **Performance evaluation of a ceramic cross-flow filter in a bench-scale gasifier.** Bachovchin, D.M. (Westinghouse Electric Corporation, Pittsburgh, PA (USA)); Smeltzer, E.M. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The performance, operational characteristics and economic feasibility of the cross flow filter for hot gas cleanup has been investigated previously. The current contract is comprised of four major technical tasks, three of which have been completed. In Task 1, a single 6 x 6 x 2 inch cross flow filter element was successfully tested on the DOE-METC bench-scale gasifier. Subsequent to this test a second 6 x 6 x 2 element was successfully tested at HTHP conditions over 1000 cleaning cycles in a 250 hr test run. In Task 2, analysis and experiments were conducted to evaluate certain system scaleup issues associated with the filter and pulse cleaning. In Task 3, a conceptual design and economic analysis of the cross flow filter was developed for three different IGCC systems. In these conceptual design studies, the commercial filter elements were taken to be 12 x 12 x 4 inch size. Current contract efforts have focused on manufacturing and evaluating the scaled-up filter elements. The remaining task, Task 4, is directed at developing a statistical basis for economically evaluating the 12 x 12 x 4 inch filter element size. This is to be accomplished by incorporating eight (8) filter elements into a single test unit and conduct a 200 hour run at the KRW-HTHP test facility. Current efforts are focused on preparing for this test. This work has included both preparation of the test facility and test unit as well as the procurement and evaluation of cross flow filter elements. Results and accomplishments on filter procurement, filter evaluations, and cross flow filter test modules are described.

23299 (DOE/METC–88/6092-Vol.2, pp. 434-443) **Gas purity considerations in coal liquefaction processes.** Kornosky, R.M. (Pittsburgh Energy Technology Center, PA (USA)); Rao, S.N. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

Gas purity requirements are a significant consideration in both direct and indirect liquefaction processes for coal conversion to liquid fuels. In direct liquefaction processes, makeup hydrogen gas can be obtained from commercially available technologies. However, improved economics in the production of makeup hydrogen will have a significant impact on the cost of liquid fuels. Recycle of treated hydrogen from the reactors has received very little attention from the point of view of integration with the plant design and economics. Low recycle gas purity can significantly reduce the distillate yield in two-stage liquefaction processes. Also, in the first stage, the extent of coal conversion depends significantly on the recycle hydrogen quality. In indirect liquefaction processes, synthesis gas composition and contaminants, such as hydrogen sulfide, carbonyl sulfide, and metal carbonyls, have a significant impact on the product yield, quality, and selectivity. Typical allowable sulfur concentrations in various indirect liquefaction processes are on the part-per-million level for Fischer-Tropsch synthesis and the part-per-billion level for methanol synthesis.

23300 (DOE/METC–88/6092-Vol.2, pp. 453-462) **Removal of H_2S from gasified coal.** Lynn, S. (Univ. of California, Berkeley (USA)). USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

When coal is gasified most of the sulfur is converted to H_2S and must be removed before the gas can be used either as a fuel or as synthesis gas. The UCB Sulfur Recovery Process (UCBSRP) is being developed as a general method for removing H_2S from gases. The H_2S is absorbed in a polyglycol ether, then reacted in the liquid phase with SO_2 to form sulfur and water. The process allows high specificity and flexibility; H_2S can be reduced to the part-per-million level or below in the presence of CO_2 and the other components of gasified coal. The CO_2 may be left in the original gas stream or it may be co-absorbed and recovered as a separate, sulfur-free product. The process thus has application both to syngas and hydrogen production from O_2 -blown gasifiers and to power production using an air-blown gasifier. The development of this process has been divided into a number of tasks: To determine the solubilities of H_2S, SO_2, CO_2, CH_4 and other hydrocarbon gases, water and sulfur in the organic solvent as functions of pressure, temperatures, and solvent composition. To determine the effects of temperature and solvent composition on reaction kinetics. To investigate the suitability of steel and other materials of construction for this system. To determine the parameters controlling the crystal size distribution of sulfur so that crystals of 100 micrometers or greater will be formed in the process. To determine the parameters controlling reactive absorption of hydrogen sulfide by solutions containing sulfur dioxide. To set up a computer model of this process to aid in its evolution. To compare the anticipated costs of this process with those of conventional technology. The current status of studies on solubility, reaction kinetics, and corrosion is described.

23301 (DOE/METC–88/6092-Vol.2, pp. 484-493) **Catalytic gasification fundamentals.** Heinemann, H. (Lawrence Berkeley Laboratory, CA (USA)); Somorjai, G.A. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The major purpose of this project is to find catalysts which will permit steam gasification of carbonaceous material at reasonable rates and at lower temperatures than currently practiced. Rapid catalyst deactivation must be avoided. An understanding of the catalytic mechanism is necessary to provide leads towards this aim. The best catalyst composition found is equimolecular mixture of KOH and NiO, although all alkali hydroxides and most transition metal oxides work. It has been established that this mixture forms

a ternary oxide, presence of which is established by XPS measurements. The ternary oxide has been shown to be stable at higher temperatures than it components and in particular preserves the plus two state of nickel in the presence of reducing agents such as carbon and/or hydrogen. Deactivation of the nickel oxide/potassium oxide catalyst during the gasification of chars has been observed and appears to be due to an interaction of the catalyst with the ash components of the char. Demineralization of the char permitted the steady state gasification after adding the catalyst to the demineralized char. Ratios of carbon monoxide to carbon dioxide in the gases produced along with hydrogen vary with different chars. The ratio is about .8 for an Illinois No. 6 char and .08 for a North Dakota lignite char. Therefore, it appears possible to produce essentially hydrogen and CO_2 without external shift reactor. Results to date are discussed.

23302 (DOE/METC–88/6092-Vol.2, pp. 504-513) **Attrition and entrainment studies related to fluidized-bed coal gasifiers.** Knowlton, T. (Institute of Gas Technology, Chicago, IL (USA)). USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

In a fluidized bed, interparticle abrasion and collision in the bed or at the grid, thermal shock and chemical reaction lead to the generation of fines which can be carried out of the bed in the exit gas stream. In fluidized-bed gasification process (and in coal conversion processes in general) the generation of carbon and ash fines is one of the major problems that must be addressed. Excessive fines generation results in increased costs for particle collection systems (e.g., in cyclones) and high fines recycle rates. The high recycle rates can impose a significant heat penalty on a process. Therefore, it is desirable to minimize the generation and the subsequent carryover of the coal char fines. To do so, it is necessary to determine the chief causes of attrition and the primary variables affecting the entrainment of fines. The effect of limestone concentration on the attrition rate of bituminous and lignite coal chars in fluidized beds was determined. Tests were conducted with limestone concentrations of 20, 35 and 50 weight percent. The effect of limestone concentration on the entrainment rate and transport disengaging height of bituminous and lignite coal chars from fluidized beds was also determined using the same limestone concentrations.

23303 (DOE/METC–88/6092-Vol.2, pp. 514-518) **Novel concept of an internal recirculation catalyst for mild gasification.** Babu, S.P. (Institute of Gas Technology, Chicago, IL (USA)); Feldkirchner, H.L. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The overall objective of this research program is to develop a catalyzed coal gasification process in which the catalyst has physical properties such that it recirculates within the gasifier instead of exiting with the char. This catalyst is said to be semivolatile. If successful, this approach would avoid the need (and attendant costs) for a catalyst recovery process step and would also greatly reduce catalyst make-up costs. An investigation was made of the effect of cesium hydroxide on the quality and quantity of coal devolatilization products, using pyrolysis-gas chromatography (PY-GC). Over 110 PY-GC experiments were conducted with Illinois No. 6 bituminous and Wyodak subbituminous coals and north Dakota lignite at two different heat-up rates of 180 F/s and 360 F/s in He, He/H_2 and He/H_2O(g) atmospheres at peak temperatures of 1000 and 1400 F. A summary of the selected experimental results shows that, in general, there is more residual char and more gaseous products produced with cesium hydroxide-catalyzed devolatilization. Consequently, the presence of cesium hydroxide catalyst leads to a reduction in the yield of condensible hydrocarbons, as shown by the yields of C_6 to C_{44} hydrocarbons. A very detailed characterization of these condensibles showed that there were no beneficial effects of cesium hydroxide on the quality of condensible hydrocarbons. Alternative inorganic compounds were considered as substitutes for cesium hydroxide. A number were selected as worth of further investigation and DOE's guidance was sought for a redirection of the technical approach. With that guidance, zinc chloride ($ZnCl_2$) was selected for testing under a no-cost time extension of this contract.

23304 (DOE/METC–88/6092-Vol.2, pp. 519-524) **Gas separations using inorganic membranes.** Egan, B.Z. (Oak Ridge National Laboratory, TN (USA)); Fain, D.E.; Kidd, G.J.; Singh, S.P.N. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The overall R&D program consists of the development of membrane separation systems for the recovery of H_2 and the separation of acid gases (H_2S, CO_2) from synthesis of gas. The program is a multiyear effort that is to be conducted in stages, with intermediate decision points to determine the course of future R&D efforts. There are two major parts to the program that are closely interlinked. Part A consists of the following elements: (1) identification of the candidate membrane materials based upon the chemistry of the separation environment; (2) evaluation of the separations capability of the fabricated membranes in terms of permeabilities and fluxes of gases; (3) assessment of the worldwide R&D activity in this field; and (4) reporting on the project. Part B comprises fabricating and physically characterizing the candidate membranes using the specialized techniques presently available only at the Oak Ridge Gaseous Diffusion Plant. Efforts will be made to transfer the technology to industry. Part A is funded by the Gas Stream Cleanup Program, and Part B is funded by the AR&TD Fossil Energy Materials Program. This is a new program, beginning in April 1988, so experimental results are not yet available.

23305 (DOE/METC–88/6092-Vol.2, pp. 532-536) **A mechanistic study of the energetic heterogeneity of coal chars.** Calo, J.M. (Brown Univ., Providence, RI (USA)); Hall, P.J. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The experimental approach involves the application/adaptation of TPD/MS (temperature programmed desorption/mass spectrometry) to the analysis of the surface energetics of coal chars. Basically, the rate of evolution of CO and CO_2 from thermal decomposition of surface oxides (formed upon exposure of surface-cleaned chars to oxygen, and other oxidizing species), in response to programmed (typically linear) heating, are monitored mass spectrometrically. The resultant TPD spectra can be analyzed in terms of desorption energies and their distributions. In the case of microporous chars and carbons, however, as desorbed species diffuse out through the micropore structure, there may be a significant probability of readsorption and/or secondary reactions with other non-desorbed species. Under such conditions, TPD chromatograms may not directly reflect the original state of the adsorbed species, and must be corrected for such transport/reaction effects. This paper describes char sample preparation and the TPD procedures and discusses TPD experimental results and the interpretation of TPD spectra from microporous coal chars.

23306 (DOE/METC–88/6092-Vol.2, pp. 537-550) **Gasification systems analysis.** Klara, J.M.; Hand, T.J. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The Gasification Systems Analysis project at METC is currently evaluating the feasibility of several gasification-based processes to

produce coal-derived products by utilizing in-house, computer-based systems analysis tools and expertise. The two area which have been the focus of this project are mild gasification and the production of low-cost hydrogen from coal gasification. For the mild gasification study, a conceptual commercial-scale plant utilizing fluidized-bed technology was designed and a detailed economic assessment was performed. Sensitivity studies have also been performed to determine the effects of coal type, feedstock price, and alternate process designs on product selling price. Mild gasification economics indicate that it may be a viable technology for producing coal-derived products. Coal-based systems for producing hydrogen consist of four major process steps: gasification, shifting of carbon monoxide, acid gas removal, and hydrogen purification. The emphasis of this analysis is to evaluate the technical and economic feasibility of replacing some of these conventional process steps with novel ones. To serve as a basis of comparison, a conventional coal-to-hydrogen process was developed which includes Texaco gasification, sulfur tolerant carbon monoxide shifting, Selexol, Claus and Scot units for sulfur removal and recovery, and conventional pressure swing adsorption with molecular sieves for hydrogen purification. Several alternative configurations using novel processes for gasification and gas separation have been developed. Assessment of the technical and economic merit of these processes is being performed.

23307 (DOE/METC–88/6092-Vol.2, pp. 551-561) **Biological degradation of low-rank coal.** Jones, W.J. (Georgia Institute of Technology, Atlanta (USA)); Chain, E.S.K. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The primary goal of this research is to assess the potential for the anaerobic bioconversion of coal to fuel products. Initial experiments were conducted to assess the potential for anaerobic bioconversion of selected model compounds, including phenol, 2-naphthol, 9-phenanthrol, and dibenzothiophene; these compounds were selected as representative constituents of low-rank coals based on available literature of low-rank coal chemistry. Experiments were designed to enhance anaerobic bioconversion of selected recalcitrant substrates via coupling to CH_4 production (use of methanogenic consortia) or via nitrate reduction. Coupling bioconversion to CH_4 production has been demonstrated for a variety of organic substrates and is advantageous because of production of a desirable end product (CH_4) and because of thermodynamic considerations. Importantly, the biologically mediated reduction of CO_2 by H_2 to CH_4 provides a mechanism for maintaining low partial pressures of H_2, resulting in favorable thermodynamic reaction kinetics for the H_2-producing species. The paper discusses analytical methods for biodegradation assessment, results from biodegradation experiments on model compounds and on low-rank coal extracts, and toxicity studies.

23308 (DOE/METC–88/6092-Vol.2, pp. 562-569) **Mild gasification char fuel development.** Chu, C.I.C. (UCC Research Corporation, Bristol, VA (USA)); Derting, T.M.; Gillespie, B.L. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The primary objective of this project is to develop a novel process for upgrading the char produced in the mild gasification process in order to enhance the economic advantages of mild gasification. The project involves: (A) designing, constructing, and testing a bench-scale char chlorination unit, (B) if bench-scale tests are successful, design, construct, and test a char chlorination process development unit (PDU), and (C) conduct gas turbine and carbon-electrode application studies with the cleaned (chlorinated) char product from the PDU. The bench-scale char chlorination tests were conducted in a batch-type rotating graphite reactor tube assembly at temperatures ranging from 2500 to 3500 F, for periods of one to five hours. Eight of the tests were conducted with 2 cubic feet per hour (cfh) of chlorine gas at temperatures of 2500, 3000, or 3500 F for periods of 1,3, and 5 hours. Three similar tests were also conducted using 2 cfh of nitrogen gas (no chlorine) at a temperature of 3000 F. The results obtained in the eleven char chlorination tests indicate that the mineral matter (ash) components in the char react with chlorine gas to form volatile chlorides, which can then be swept from the reactor. The results also show that increased temperature increases the rate at which the chlorine reacts with the mineral matter components. At temperatures of approximately 3000 F and higher, the ash content of the char was reduced from 12.85% to approximately 1% after one hour, with a corresponding reduction in sulfur from 1.10% to approximately 0.60%. After five hours at 3500 F, the ash content of the char was further reduced to 0.06% while the sulfur content was reduced from 1.10% to 0.07%.

23309 (DOE/METC–88/6092-Vol.2, pp. 570-573) **Mild gasification of coal.** Ness, R.O. Jr. (Univ. of North Dakota, Grand Forks (USA)). USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The objective of this research program are to perform preliminary process evaluations of mild gasification of North American coals using a 1 lb/hr continuous fluid bed gasifier (CFBG). The products from the process will be characterized for possible use as a metallurgical coke, feedstock for catalytic steam gasification for hydrogen production, diesel fuels, liquid feedstock additives, and gaseous fuels. This effort will provide the early stage for engineering development and basic operating parameters necessary for process scaleup. Preliminary yields were calculated using analytical techniques. These results were used to design the CFBG. The unit has just been completed and is undergoing shakedown testing. Ten shakedown runs have been completed using lignites, subbituminous, and bituminous coals at 650 C and 2:1 steam/coal ratio. Complete material balances were not available for these runs but several of the chars were analyzed. The coal char volatile content varied from 18% to 12%. The char bed materials were approximately 9%.

23310 (DOE/METC–88/6092-Vol.2, pp. 574-589) **Mechanisms and characterization of mild gasification processes.** Khan, M.R. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The objectives of this study are to investigate the influence of devolatilization conditions (e.g., reactor type, feed type, etc.) on the products' quality/yield by comparing the devolatilization products obtained at a range of temperatures and heating rates. Correlations between the total feed coal sulfur and char, tar and total gaseous sulfur have been obtained. The char sulfur could be correlated somewhat with the pyritic sulfur content. However, correlations between sulfur type (organic, pyritic, or sulfatic sulfur) with the sulfur and content in the products were generally poor. It is shown that about 61% of coal sulfur appears in the char while about 31% of coal sulfur appears in increase in the gaseous products when coal is pyrolyzed at 500 C. With the increase in the peak devolatilization temperature, however, the gaseous sulfur yield increases monotonically for the Pittsburgh No. 8 at the expense of char sulfur. Measurements of the refractive indices of the pyrolysis liquids derived from various feedstocks (coal, oil shale, or tar sand) were made and appear to correlate well with the liquids' physical and chemical properties. The refractive indices of the pyrolysis liquids show good correlations with liquid density, carbon and proton aromaticities and Conradson carbon residue. These correlations were developed using data from at least 7 to as many as 35 discrete samples. The correlations have been used to develop empirical models. These findings demonstrate the potential of using the liquids' refractive index as a rapid technique to characterize the fuel related properties of fossil fuel liquids generated by pyrolysis.

23311 (DOE/METC–88/6092-Vol.2, pp. 590-594) **Novel electrochemical process for coal conversions.** Farooque, M. (Energy Research Corporation, Danbury, CT (USA)); MacDonald, J.; Kush, A.; Gidaspow, D. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The electrochemical approach to coal conversion, not systematically examined previously, which may provide gasification and/or hydrogenation of coal at less severe conditions is the subject of this study. In this approach, the energy of activation for the reaction is supplied in the form of electricity at a desired temperature. The controllability of temperature and energy input may allow a broader flexibility over the product selectivity. Additional benefits that may be realized from the fundamental understanding and experimental techniques developed in this study are (a) processes to upgrade coal and (b) a convenient technique to analyze coal surface chemistry. The program first focuses on characterization of the electro-reduction and electro-oxidation approaches to coal conversion in laboratory scale cells, in parallel efforts. Test plans for the electro-reduction and electro-oxidation experiments were formulated to investigate the effect of process variables. Computer modeling will be utilized to investigate the hydrodynamics of the electro-oxidation slurry reactor. The mathematical model will provide a useful tool for improved cell design and scaleup. Selection of the most promising route for further development will be based on comparison of the two processes with respect to product usefulness, product selectivity, efficiency of conversion, reaction kinetics and cost. A scalable cell for the selected process will then be designed, constructed and evaluated experimentally. Results are discussed of the eletro-oxidation tests and the computer modeling efforts to date. Results are also presented on the electro-reduction studies.

23312 (DOE/METC–88/6092-Vol.2, pp. 595-599) **Fundamental investigations of cleavage and crosslinking of coal polymers in laser-heated pyrolysis.** McMillen, D.F. (SRI International, Menlo Park, CA (USA)); Malhotra, R. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The ultimate objective of this project is to develop procedures that will increase the yield and/or quality of condensible coproducts during coal pyrolysis or mild gasification. The specific objectives involve improving the understanding of the chemical (and physical) factors controlling volatiles release by the use of (1) pyrolysis procedures that tend to minimize secondary reactions of evolved volatiles, and (2) coal pre-treatments that are indicated by our evolving knowledge of pyrolysis and gasification chemistry to promote bond scission and/or prevent retrograde reactions. The authors rely primarily on two unique pyrolysis procedures in this project. The first is pyrolysis in the temperature=programmed source of a field ionization mass spectrometer (FIMS), a technique already shown to be extremely useful under slow heating in high vacuum. The second is infrared laser pyrolysis of an entrained flow of coal particles. Results to date are presented.

23313 (DOE/METC–88/6092-Vol.2, pp. 600-604) **Mild coal gasification.** Camp, D.W. (Lawrence Livermore National Laboratory, CA (USA)); Mallon, R.G. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The overall objective is to produce information needed for the development of an efficient continuous process for the mild gasification of caking bituminous coals. Four specific objectives are to: (1) Apply oil shale experience to the review and/or conception of mild gasification processes; (2) Provide technical assistance for DOE's batch mild gasification unit (operated in Bristol, Virginia by United Coal Company); (3) Select, install, and operate a small-scale mild gasification system of a promising type to produce scaleup information; and (4) Characterize the pyrolysis behavior of appropriate coals in a way useful for process design and development. The authors have recommended three processes as being the best candidates for further development. These are the hot-recycle-char entrained-flow flash pyrolyzer (e.g. Occidental), the hot-recycle-char twin-screw-mixer flash pyrolyzer (e.g. Lurgi-Ruhrgas), and the externally-heated screw pyrolyzer, both single-screw (e.g. Hayes) and twin-screw versions (new, Camp). An attractive long term concept is coupling a flash pyrolyzer, heated by circulating limestone, to the feed end of a limestone fluidized-bed combustor (Longwell concept). Results to date are discussed.

23314 (DOE/METC–88/6092-Vol.2, pp. 605-614) **Measurement and modeling of advanced coal conversion processes.** Serio, M.A. (Brigham Young Univ., Provo, UT (USA)); Hamblen, D.G.; Brewster, B.S. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The overall objective of this program is to understand the chemical and physical mechanisms in coal conversion processes and incorporate this knowledge in computer-aided reactor engineering technology; the technology to be appropriate for the development, evaluation, design, scale up, simulation, control and feedstock evaluation in advanced coal conversion devices. To accomplish this objective, the study will: establish the mechanisms and rates of basic steps in coal conversion processes, incorporate this information into comprehensive computer models for coal conversion processes, evaluate these models, and apply them to gasification, mild gasification and combustion in heat engines. Results to date include: Successful validation of the combined FG-DVC (Functional Group-Depolymerization, Vaporization, Crosslinking) model of coal devolatilization using data acquired under this program and literature data; Integrated FG/DVC and PCGC-2(2-D reactor model); Demonstrated importance of variability in coal offgas enthalpy on comprehensive code predictions; Installed the integrated comprehensive model on a Sun 3/260 Workstation; Developed and implemented a submodel for thermal NO formation in the comprehensive code; Identified mechanisms of ignition and soot formation and discovered a new ignition phenomenon; Completed the design and initiated construction of an advanced reactor for measuring kinetic rates of char oxidation at high pressure with optical access and a cold-flow facility for studying mixing patterns in sorbent injection; and Reviewed existing fixed-bed models and developed a research plan for an advanced model. Formulated and initiated coding of an improved model to provide the foundation of the advanced model.

23315 (DOE/METC–88/6092-Vol.2, pp. 615-627) **Fundamental mechanisms of coal gasification.** Howard, J.B. (MIT, Cambridge, MA (USA)); Peters, W.A. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The overall objective is to advance current understanding of coal physics and chemistry to allow improved, quantitative predictions of coal devolatilization behavior under gasification conditions. Our specific objectives are to: (1) Study the role of intra-particle chemical kinetic and transport rate phenomena in coal devolatilization; (2) Experimentally determine how coal type influences coal devolatilization behavior including product yields, compositions and evolution kinetics; and (3) To develop an integrated mathematical model of coal devolatilization under coal gasification conditions. The approach involves experimental measurements of coal devolatilation products yields and production rates. The apparatus provides for manipulation of physical and chemical rate processes and allows

study of independent effects of coal type and reaction conditions of practical interest such as temperature, heating rate, holding time, pressure, and particle size. To this end, heavy reliance is placed on various versions of the electrical screen heater reactor which provides for the above measurement requirements, while offering good material balances and amenability to kinetic interpretation. The work also involves developing mathematical correlations and models of devolatilization kinetics. Results to date are detailed.

23316 (DOE/METC–88/6092-Vol.2, pp. 638-648) **Development of a gasifier energy storage system.** Page, G.C. (Radian Corporation, Austin, TX (USA)); Raden, D.P.; Skinner, F.D. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The ultimate objective of this program is the development of an integrated system for producing carbon-based products from coal that (1) is based on existing low-cost gasification technologies, (2) can utilize all coal types as feedstocks, (3) does not require exotic materials of construction, (4) produces a product with high market value, and (5) has significant cost advantages. In order to meet this overall objective in a cost-effective manner, a phased approach is being implemented. These phases are: technical and economic evaluation, fuel characterization, bench-scale reactor testing, and pilot demonstration/full-scale fuel utilization testing. The present project includes only the first two phases, i.e., technical and economic evaluation and fuel characterization. The objective of the technical and economic evaluation is to determine whether the concept is technically feasible and economically attractive. If this evaluation is favorable, then the next step will be the evaluation of the fuel characteristics of selected commercially-available carbon fuels. The objective of this task will be to obtain chemical and physical data for a preliminary assessment of product value and uses. This paper discusses clean carbon production, reactions involved in clean carbon formation from coal-derived gas, catalysts for carbon deposition, reaction kinetics, influence of other species on the rate of carbon formation, and possible process configurations.

23317 (DOE/METC–88/6092-Vol.2, pp. 649-661) **Biological gasification of coals.** Barik, S. (ARCTECH, Inc., Alexandria, VA (USA)); Isbister, J.D. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

This project addresses the program area of Fundamentals of Coal Gasification Chemistry/Coal Derived New Fuel Forms. The program has three specific objectives: To demonstrate on a laboratory scale and microbial conversion of three coals (North Dakota Lignite, Wyodak subbituminous and Ohio butuminous) to methane; to demonstrate the microbial conversion of coal to methane in a continuous bench-scale process; and to develop design criteria for pilot-scale and economic analysis for full-scale microbial coal to methane conversion units. Five technical tasks will be implemented to address the objectives of this project. Coal will be treated chemically or microbially to produce water soluble products suitable for further aerobic bioconversion to lower molecular weight products which can in turn serve as feedstock for anaerobic conversion to methane. Chemical depolymerization of lignite and subbituminous coals has been achieved using several different pretreatments and solubilizing agents. Optical density at 450 nm was used as a measure of depolymerization for both chemical and biological experiments. Inocula from sources such as sewage sludge, chicken waste, horse manure/hay compost, and leaf litter compost were adapted for growth on coal or coal depolymerization products. All cultures produced methane, as determined by gas chromatography. Methane production varied with the source of inoculum and increased with the time of adaptation; this adaptation process will be continued to develop cultures with maximum methane production from each coal. Visual observations during the course of these experiments indicated a change in color of the reaction medium associated with coal depolymerization.

23318 (DOE/METC–88/6092-Vol.2, pp. 662-668) **Advanced studies of the biological conversion of synthesis gas to methane.** Clausen, E.C. (Univ. of Arkansas, Fayetteville (USA)); Gaddy, J.L. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The objective of this research is to study advanced topics related to developing an economic process for biologically converting coal synthesis gas to a higher value gaseous fuel. The results from this program should have lead to the development of a simple and economical process alternative to high-temperature, high-pressure shift conversion and methanation in producing methane from coal synthesis gas. Cultures that operate at ordinary temperature and pressure, with retention times of only a few minutes for complete conversion to methane, will be developed. Inexpensive reactors that maximize cell density and conversion without agitation are under study. Mass transfer and kinetic parameters for scale-up of PDU and commercial units will be developed. Results are discussed from studies on culture optimization, mass transfer and kinetics, and sulfur toxicity in continuous culture.

23319 (DOE/METC–88/6092-Vol.2, pp. 669-679) **Development of a mild gasification process.** Chu, C.I.C. (UCC Research Corporation, Bristol, VA (USA)); Montafia, S.; Gillespie, B. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

Under a previous contract with Morgantown Energy Technology Center, UCCRC built and tested the 1500 lb/day mild gasification unit (MGU). The MGU was found to suffer from several shortcomings, which prevented it from operating under optimum conditions. The major problems were: (i) the large, fixed-bed reactor tubes resulted in extremely slow heating rates and low liquid yields; (ii) constant plugging in the coal feed system; (iii) the inefficient indirect condensing system; and (iv) gas leaks in and around the bottom of the reactor tube and char chamber. In light of these problems, the goals of the current project have been set to: (i) modify existing MGU facility to eliminate or alleviate the problems mentioned above; (ii) conduct more in-depth parametric tests with a view to optimize the MGU operation, (iii) characterize the co-products and identify potential end uses, and (iv) generate sufficient co-products to test char and char/coal blends as an industrial boiler/foundry fuel and to facilitate other DOE-sponsored programs for characterization and evaluation of the condensible hydrocarbons. Results to date are discussed.

23320 (DOE/METC–88/6092-Vol.2, pp. 680-689) **Mild gasification of coal.** Fallon, P.T. (Brookhaven National Laboratory, Upton NY (USA)); Sundaram, M.S. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The objective of this task is to conduct bench-scale tests for mild gasification of coal with emphasis on Eastern coals for the purpose of determining the process chemistry, the yields of co-products and the quality of products obtained and to correlate the data with the process variables. The BNL entrained tubular reactor in the Process Sciences Division has been modified to provide the process conditions necessary to conduct an experimental test matrix which covers the range of process variable of interest to the mild gasification system. A factorial experimental plan has been designed to guide the experimental program. The reactor is operated to collect all the products during and after each run. From the analyses of the products, mass balances are made for each run, the yields are

calculated and the data correlated using statistical methods for determining effect and importance of each of the process variables. Results on the effect of coal type, the interaction of process variables are summarized.

23321 (DOE/METC–88/6092-Vol.2, pp. 690-694) **Development of an advanced continuous mild gasification process for the production of co-products.** Onischak, M. (Institute of Gas Technology, Chicago, IL (USA)). USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The program has been divided into four significant tasks: Task 1. Literature Survey and Market Assessment, consisting of a comprehensive literature survey of available data on mild gasification process, co-products upgrading technology, co-products utilization methods, and a market assessment for the co-products made by mild gasification; Task 2. Bench-Scale Mild Gasification Study, an optional task comprising a technology development program to determine the performance of innovative and advanced concepts in mild gasification technology; Task 3. Bench-Scale Char upgrading Study, an optional task consisting of technology development investigations to evaluate selected char upgrading and char utilization methods; and Task 4. System Integration Studies, an optional task to be conducted subjected to DOE approval to demonstrate the performance of mild gasification in a process development unit (PDU). During the first six months of the program, Task 1 has been completed, and a topical report summarizing the work done was submitted. The paper discusses the findings of this assessment. Authorization to proceed with Tasks 2 and 3 has been obtained and a test plan is being developed.

23322 (DOE/METC–88/6092-Vol.2, pp. 695-703) **Advanced concept for the production of co-products.** Jha, M.C. (Western Research Institute, Laramie, WY (USA)); Breault, R.W.; Merriam, N.W. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The program consists of four tasks: (1) covering the literature survey and market assessment; (2) primarily studying bench-scale mild gasification; (3) studying bench-scale char upgrading; and (4) conducting system integration studies. Literature surveys of mild gasification processes and char, condensibles, and gas upgrading and utilization methods have been completed. Industrial market assessment of the products of mild gasification has also been completed. Producing anode-grade carbon to be used by aluminum companies appears to be the most attractive market for upgrading char. As a 2-million-tons-per-year domestic and 5-million-tons-per-year world market, this product commands over $100/ton delivered price. A second choice would be upgrading the char to activated carbon, which can be used in water treatment and pollution control. Although the market is comparatively small, at 150,000 tons per year, the price is attractive (up to $1000 per ton) and the cost of upgrading should be low. Markets for the liquid products of mild gasification require four separate marketable products: (1) dirty pitch, (2) clean pitch, (3) heavy oil, and (4) light oil. Uses for these are described. A high Btu gas can be used to produce chemicals such as methanol. Its conversion to a pipeline gas, while technically feasible, is at present economically unattractive. The best economic returns may result by burning it in a gas turbine located at the mine to produce power for use at the mine. The proposed plant would be built at the AMAX Belle Ayr Mine in Wyoming and use existing crushing, screening, and drying equipment as well as off-site facilities. Major features of the process are described.

23323 (DOE/METC–88/6092-Vol.2, pp. 704-709) **Advanced concept for the production of co-products.** Chu, C.I.C. (UCC Research Corporation, Bristol, VA (USA)); Miin, T.; Gillespie, B.L.; Wright, R.E.; Montafia, S. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

UCCRC, after completion of the literature survey, concluded that no commercially viable continuous mild gasification process exists. However, data found during the literature survey indicated that the most promising avenue to explore was some type of screw reactor configuration. A preliminary screw design was presented to UCCRC's staff for review and evaluation, and this concept was adopted. UCCRC's staff believes that if careful considerations are given to this screw design, problems encountered with caking coals can be overcome. To aid in the thermal efficiency, a dryer/preheater section is planned to preheat the entering coal with the products of combustion produced in the screw reactor retort. After devolitization of the coal has been accomplished, the char will be removed from the screw shaft and discharged (without cooling) to the coker retort. The gas produced in this process will be utilized as process fuel. The expected yield per ton of bituminous coal is 0.8 to 1.2 bbl/liquids and 1200 lbs/coke. The expected revenues per ton of bituminous coal, are (1) $13.60 to $20.40 from liquid sales and $48.00 from coke sales. The estimated cost to process a ton of bituminous coal, including amortization, operating costs, maintenance and spare parts, feedstock, taxes and insurance, and overhead is $48.00. Thus, the revenue received from coke sales will cover the estimated cost to process a ton of bituminous coal.

23324 (DOE/METC–88/6092-Vol.2, pp. 710-715) **Advanced concept for the production of co-products.** Ness, R.O. Jr. (Univ. of North Dakota, Grand Forks (USA)). USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The primary objective of this program is development of a continuous mild gasification process to produce a product mix to optimize process economics. The project is divided into four tasks, with Task 1 being an analysis of the marketability of mild gasification co-products and an identification of process data needs based on a literature review. Since a profitable product slate was identified, and no technological barriers to implementation were found, the second and third optional tasks to develop coal and process specific data were begun. The fourth optional task will validate the integrated process and provide design data to private industry for their assessment of economic potential and commercialization feasibility. A summary of the key findings from the market assessment is presented. The proposed integrated Mild Gasification - PTC (Pellet Technology Corp.) Ironmaking - Cogeneration Plant would consist of the following process steps: (1) Mild gasification would be performed in fluid-bed gasifiers which would be staged to accomplish drying (if necessary), primary devolatilization, calcining (if necessary), and char cooling and heat recovery. (2) Char upgrading may not be necessary. Steel has been produced with the PTC process using non-upgraded char. (3) Char would be blended with iron feedstocks, lime, silica, and water and made into pellets using the PTC process. (4) Molten metal would be produced from the pellets in a hot blast cupola. (5) Condensable hydrocarbons would be processed by extraction or hydrotreating and distillation to produce chemical feedstocks (benzene and phenol) or for production of railroad diesel fuel. Fuel gases, distillation bottoms, and char fines would be fed to a boiler to produce steam for process heat and cogeneration of electricity.

23325 (DOE/METC–88/6094, pp. 107-111) **Bench-scale tests of alkali vapor removal from PFBC [pressurized fluidized-bed combustion] exhaust using a fixed bed of activated bauxite sorbent.** Lee, S.H.D. (Argonne National Laboratory, IL (USA)); Carls, E.L. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the*

annual coal fuel heat engines and gas stream cleanup systems contractors review meeting. Order Number DE88001088. Available from NTIS, PC A20/MF A01.

Vapor-phase alkalis present in the hot exhaust from PFBC are expected to penetrate through a particulate-removal device. These alkalis could cause corrosion of the PFBC gas turbine. A fixed granular-bed sorber is being developed at Argonne National Laboratory (ANL) for the control of the alkali vapor in PFBC exhaust. After an extensive screening study, activated bauxite was found to be the most effective sorbent in capturing NaCl, KCl, and K_2SO_4 vapors that were doped into a simulated PFBC gas stream. Activated bauxite was also demonstrated to be easily and effectively regenerated for reuse by a simple water-leaching process. The effectiveness of activated bauxite for alkali-vapor capture has been confirmed by others. During this reporting period, tests with the PFBC/alkali sorber unit were conducted to establish a reliable sampling technique for alkali-vapor measurement and to quantify the level of alkali vapors in the PFBC exhaust. Results of these two tests are presented.

23326 (DOE/METC–88/6094, pp. 201-210) **Integrated low emissions cleanup system for direct coal-fueled turbines - moving-fluid bed contactors/ceramic filters.** Newby, R.A. (Westinghouse Electric Corporation, Pittsburgh, PA (USA)); Alvin, M.A.; Bachovchin, D.M.; D'Amico, N.; Yang, W.C.; Smeltzer, E.E. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The objective of this program is to demonstrate the conceptual feasibility of two advanced, high-temperature gas cleaning concepts for direct coal-fired turbines: a moving bed contactor coupled with high-temperature barrier filters, and a fluidized-bed contactor with integral high-temperature barrier filters. These are compact devices that perform simultaneous sulfur removal, alkali removal, and particulate removal. Five laboratory test efforts have been identified to be performed in Phase 1. They are: Hydrodynamic Modeling; Sulfur Removal; Alkali Removal; Combined Sulfur-Alkali Removal; and Coal-Ash/Sorbent Behavior. These test support the bench-scale testing to be performed in Phase 3, providing the design basis for the bench-scale equipment and producing preliminary criteria for commercial equipment design. Preliminary results are discussed from these five studies.

23327 (DOE/METC–88/6094, pp. 211-217) **Integrated low emissions cleanup system for direct coal-fueled turbines (electrochemical reactor) - Phase I.** Gordon, A.Z. (Helipump Corporation, Cleveland, OH (USA)); Siwajek, L.A. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The objective of this project is to develop means for the effective reduction of NO_x/SO_2 in direct coal-fueled turbines. The technology will utilize a solid oxygen ion conductive ceramic to disassociate NO_x/SO_2 molecules into their elemental constituents. An analysis of the integrated unit with particulate removal, NO_x/SO_2 reduction and turbine will be performed, as well as an economic evaluation. Phase I of this project concerns itself predominantly with the selection of optimal materials to be used as electrolyte, electrode and electrocatalyst for the reduction of NO_x/SO_2. The experimental apparatus will be a bench scale reactor which will operate between 1600 and 2500 F at one atmosphere total pressure. The project is still in its early stage, so no results are available as yet.

23328 (DOE/METC–88/6094, pp. 218-227) **Electrostatic agglomeration for particulate control after sorbent injection.** Feldman, P.L. (Cottrell Environmental Sciences, Somerville, NJ (USA)); Kumar, K.S.; Bannister, R.L.; Diehl, R.C. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The objective of this contract is to investigate the removal of SO_x and particulate matter from direct coal-fired combustion gas streams at high temperature and high pressure conditions. This investigation will be accomplished through a bench-scale testing and evaluation program employing the sorbent injection technique for SO_x removal, and an innovative particulate control concept that utilizes electrostatic agglomeration followed by a high efficiency, Van Tongeren type mechanical collector. The process goal is to achieve particulate collection efficiency better than that required by the 1979 new source performance standards. An additional goal is to demonstrate 70-90% SO_x removal efficiency by sorbent injection near the discharge zone of the combustor. The progress under this contract has been in Phase I - cleanup system design and preliminary evaluation. Specific results to date have been in the development of system specification and agglomerator sizing. Presently the focus is on the choice of materials for the internals of cleanup system. Materials such as silicon carbide are being researched for fabricability, and ease of changeout, etc. Methods of dust/slag removal from ESA are also being considered because of the potential for stickiness at the direct coal fired turbine conditions. The paper describes the bench-scale system, test combustor, sorbent injection system, and the particulate collector system. The test program and economics are briefly discussed.

23329 (DOE/METC–88/6094, pp. 283-294) **Electrochemical abatement of pollutants NO_x and SO_x in combustion exhaust gases employing a solid-oxide electrolyte.** Mason, D.M. (Stanford Univ., CA (USA)). USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The objective of this contract is to test the feasibility of eliminating the pollutant species NO and SO_2 in combustion exhaust gases by pumping off oxygen employing a dry solid-oxide, oxygen-ion type electrolyte system. At the same time to conserve electrical power for pumping it is desirable not to have to pump off any unreacted O_2 that may remain in the exhaust gases. The applications in mind are treating exhaust gases from such devices as internal combustion engines, gas turbines and power-plant flue gases in the 400-700 C temperature range as well as the cleanup of high pressure, combustion gas prior to entering a gas turbine in the 700-1000 C temperature range. In optimizing the design of an electrochemical pollution-abatement reactor it is necessary to have a quantitative understanding of the basic chemical processes occurring in the system. To this end, a study of the effect that electrode morphology, electronic defect population as well as electrolyte composition has on electrocatalytic reaction-rates is being undertaken. The precise nature of the electrocatalytic role played by electronic defects, such as F-centers, is being elucidated. Results to date are described.

23330 (DOE/METC–88/6094, pp. 316-327) **GE gas turbine environmental and deposition control.** Kimura, S.G. (GE Aircraft Engine, Cincinnati, OH (USA)); Lavigne, R.G.; Slaughter, D.M.; Spiro, C.L.; Staub, F.W. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The system concept for this program uses an LM500 advanced aero-derivative gas turbine engine designed for direct firing of coal fuel. This system can be used in transportation and small stationary power applications. The coal-fueled gas turbine components developed will be fabricated and incorporated into an LM500 gas generator for integrated system testing with the coal fuel. The key

elements in the GE Advanced Coal-Fired Gas Turbine environmental control strategy are beneficiation, combustion, sulfur capture and particulate capture. Nitrogen oxide will not explicitly be removed from the gas stream; NOx abatement will be through combustion modification. Two locations for SO_2 abatement are upstream or downstream of the turbine. In the former method, sorbents are to be coinjected with the fuel, while the latter process employs dry FGD. Dry FGD approaches represent commercial or near-commercial technology; sorbent injection for sulfur capture requires considerable research and development. Sulfur sorbents for direct injection were identified and evaluated for sulfur capture, first with sulfur-doped oil, and then with coal. It was concluded that unless a major improvement in deposit control could be achieved, direct sulfur sorbent injection with the coal-fuel would require combustion exit gas cleanup before it enters the turbine. The option of using a granular bed filter (GBF) between the combustor/sorbent injection system and the turbine for particulate and SO_2emission control was investigated. Results are described. A major technical impediment to exhaust gas sulfur and particulate cleanup is deposition in the turbine due to residual ash in the coal fuel. Therefore, considerable effort was put into deposit remediation. These results are also described.

23331 (DOE/METC–88/6094, pp. 328-337) **Turbine protection system in coal-fired gas turbines: Technical progress report.** Vittal, B.R. (General Motors Corporation, Indianapolis, IN (USA)); Skinner, J.E.; Snyder, P.H.; Bennett, W.A.; Barta, A.B. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The objective of this program is to establish the means to effectively protect the turbine hardware in a direct coal-fired gas turbine engine from deposition and erosion by gas stream particulate. The method of protection is to the use of an integrated particle separation system. The system should be compact to allow for use in locomotive and cogenerative applications. The design of this system includes the evaluation of the separator performance, its impact on the engine performance, and an evaluation of the deposition and erosion effects in the turbine. The particle separator development is broken into three subtasks. The first of these is the preliminary separator design. This includes the establishment of the separator system requirements, the evaluation of various separator concepts, the selection of primary and alternate concepts for further study, and preliminary design utilizing analytical design tools. The second subtask is the fabrication and testing of cold flow scaled versions of the preliminary design and alternate configurations. During this time, both aerodynamic and particle separation testing are performed. From this testing, a design is selected to be incorporated into hot flow hardware during the third subtask. This hot flow hardware will then be fabricated and tested during full scale combustor rig testing. To assess the damage to turbine vanes and blades caused by unseparated particulate, an Allison developed particle trajectory code has been adapted to the turbine design system. This code will be used to assess the amounts of erosion and deposition on the Allison proof-of-concept (POC) 501 engine turbine stators and rotors. Results from the first two subtask are presented.

23332 (DOE/METC–88/6094, pp. 338-349) **Environmental control systems in coal-fueled gas turbines: Technical progress report.** LeCren, R.T. (Solar Turbines Incorporated, San Diego, CA (USA)); Hendrix, H.L.; Cowell, L.; Hasan, A. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The objective of this task of the contract is to develop a reliable system of environmental control for coal-fueled gas turbine systems. The ability to operate a gas turbine in a direct coal-fueled mode for an economic lifetime is dependent on the efficiency of the particulate removal system. Also, a coal-fueled system must be prepared to meet ever-tightening environmental restrictions with regards to gaseous and particulate emissions. This task of the contract deals with the removal of particulate via an impact separator and barrier filters and the removal of sulfur oxide emissions by use of suitable sorbents injected into the gas stream. Results to date from the Particulate Rejection Impact Separator (PRIS), sorbent injection studies, and secondary zone cleanup with ceramic filters are discussed.

23333 (DOE/METC–89/6099, pp. 2-12) **Performance evaluation of a screenless (counter-current) granular bed filter on a subpilot-scale PFBC [pressurized fluidized bed combustor].** Haas, J. (Combustion Power Company, Menlo Park, CA (USA)); Cooper, J.; Wilson, K. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The objectives of this investigation are: (1) to augment information on the feasibility of a Granular bed Filter (GBF) for controlling particulate in a Pressurized Fluidized-Bed Combustor (PFBC) power generating system (2) to assess the design and life of critical components in the filter system, and (3) to estimate costs of a commercial-scale design based on tested concepts. Granular bed filter equipment for the New York University testing, a pressurized fluidized-bed combustor, and results to date are described.

23334 (DOE/METC–89/6099, pp. 13-22) **Performance evaluation of a ceramic cross-flow filter in a bench-scale gasifier.** Bachovchin, D.M. (Westinghouse Electric Corporation, Pittsburgh, PA (USA)); Smeltzer, E.M. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The performance, operational characteristics and economic feasibility of the cross flow filter for hot gas cleanup has been investigated previously. The current contract is comprised of four major technical tasks; three of the tasks have been completed. In Task 1, a single 6 x 6 x 2 inch cross flow filter element was successfully tested on the DOE-METC bench-scale gasifier. Subsequent to this test a second 6 x 6 x 2 element was successfully tested at HTHP conditions over 1000 cleaning cycles in a 250 hr test run. In Task 2, analysis and experiments were conducted to evaluate certain system scaleup issues associated with the filter and pulse cleaning. In Task 3, a conceptual design and economic analysis of the cross flow filter was developed for three different IGCC systems. In these conceptual design studies, the commercial filter elements were taken to be 12 x 12 x 4 inch size. Current contract efforts have focused on manufacturing and evaluating the scaled-up filter elements. The remaining task, Task 4, is directed at developing a statistical basis for economically evaluating the 12 x 12 x 4 inch filter element size. This is to be accomplished by incorporating eight (8) filter elements into a single test unit and conduct a 200 hour run at the KRW-HTHP test facility. Current efforts are focused on preparing for this test. This work has included both preparation of the test facility and test unit as well as the procurement and evaluation of cross flow filter elements. Results and accomplishments on filter procurement, filter evaluations, and cross flow filter test modules are described.

23335 (DOE/METC–89/6099, pp. 23-27) **Development of a novel nested-fiber filter concept for high-temperature and high-pressure physical cleanup.** Conkle, H.N. (Battelle Columbus Division, OH (USA)). USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The project objective is to develop a gas-filtration system capable of operating at high temperatures and pressure (HTHP) for use in IGCC and PFBC applications. The Nested Fiber Filter (NFF) system is based on the concept of a nest of needle-like fibers made from an alloy suited for the application. Filter action results

from particulate matter forming dendritic, or chain-like, structures on the surface of the fibers. The test results showed that face velocity was the most significant filter parameter. The tests showed that a 180- to 250-mm bed of 13-mm-long fibers operated at 0.5 to 1 m/s face velocity with < 44-μm fly ash resulted in collection efficiencies ranging from 99.0 % with 200- to 300-mm-water pressure drop. Size analysis of the fly ash leaving the NFF indicates that all material was smaller than 3 μm in diameter. Elevated pressure, over the range of 1 to 6 atmospheres absolute, showed no statistically significant effect on capture efficiency. Pressure drop, however, increased as the pressure was raised due to the increased density of the gas. A series of high-temperature tests evaluated the NFF performance up to 1570 F. These tests confirm the expectation that outstanding particulate capture is maintained at high face velocity and low-pressure drop. Fly ash known to have a small average particle size (4.6 μm). was used to test collection efficiency. The AFBC ash used for most of the tests had a mean size of 6.2 μm and a broader size distribution. The NFF collection efficiency was excellent with the finer particulate. Three techniques have been tested for cleaning/regenerating the NFF: rotation, vibration, and pulse-jet flow. Vibration is the most effective cleaning technique for the present test modules. Cleaning will be evaluated further as part of the Mechanical Development effort.

23336 (DOE/METC–89/6099, pp. 28-32) **Subpilot scale gasifier evaluation of ceramic cross-flow filter.** Lippert, T.E. (Westinghouse R and D, Pittsburgh, PA (USA)); Bachovchin, D.M.; Smeltzer, E.E.; Robin, A.M. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The overall objective of this project is to verify the suitability of ceramic cross-flow filter technology for use in a coal gasification environment. Westinghouse is designing as system, containing several full-scale (12 x 12 x 4 inch) filter elements, that will be tested at the Texaco Coal Gasification Pilot Plant in Montebello, California. Specific goals of the program include: demonstrate successful operation of the full-scale ceramic cross-flow filter element in the gasification environment; identify and resolve any mechanical or operational concerns introduced by the gasification conditions; develop concise system related design procedures for use in scale-up and design; and develop the operating and installed costs of the filter concept, and relate to effects on the overall process and on emissions. No results are available as yet.

23337 (DOE/METC–89/6099, pp. 33-36) **Long-term durability testing of ceramic cross-flow filter.** Smeltzer, E.E. (Westinghouse Electric Corporation, Pittsburgh, PA (USA)); Bachovchin, D.M. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The objective of this work is to assess the long-term mechanical integrity and chemical stability of components and materials used in construction of the ceramic cross-flow filter by conducting long-term durability tests under simulated PFBC and reducing gas conditions, with fly ash and char. A second objective will be to compile a comprehensive commercialization study encompassing surveys of market sector, demand, and estimates of unit production cost and selling price. Experimental procedures, including test conditions for both the reducing gas and PFBC simulators, are described. No results are available as yet, but preliminary work is described.

23338 (DOE/METC–89/6099, pp. 38-62) **Sidestream zinc ferrite regeneration tests: Laboratory-scale study of reductive regeneration of zinc ferrite sorbents.** Grindley, T. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

In the course of the development of regenerable, zinc-based sorbents for the desulfurization of the hot gas derived from coal gasification, it has become evident that oxidatively regenerated sorbents inevitably contain a considerable amount of residual sulfur in the form of zinc sulfate. This zinc sulfate tends to decompose in the initial stages of absorption when the oxidatively regenerated sorbent is brought back on-line. Until the regenerated sorbent is in its reduced form, the decomposing sulfate releases a high concentration of sulfur species, including SO_2, H_2S, and COS, into the gas stream. This undesirable result can be avoided by reducing the oxidatively regenerated sorbent in a reductive regeneration step so that the sorbent can be returned to service in its reduced form. It is proposed that the reductive regeneration be achieved either by recycling hot clean gas or passing partially combusted natural gas through the sorbent until it is reduced. The tail gas from the process may be injected into the gasifier or upstream of the on-line absorber. In order to establish the most suitable conditions for reductive regeneration, METC conducted an experimental study of the reduction of a zinc ferrite sorbent which had been oxidatively regenerated under pressure in a process development unit. Experimental procedures are described and results are discussed.

23339 (DOE/METC–89/6099, pp. 63-72) **Enhanced durability and reactivity for zinc ferrite desulfurization sorbent.** Berggren, M.H. (AMAX Research and Development Center, Golden, CO (USA)); Harrison, D.P. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The prime objective of this project is to identify and investigate methods for enhancing the durability and reactivity of the zinc ferrite desulfurization sorbent. The objective is being accomplished by preparing a large number of sorbent samples representing modified chemical compositions and different preparation and induration procedures. Selected samples which meet the requirements of the physical characteristics are being used in cyclic sulfidation/regeneration tests to determine their reactivity. These sorbent samples are being characterized before and after cyclic testing to determine their durability. The resulting data are being analyzed to categorize the sorbents and to establish the chemical composition and preparation procedures that will result in the most reactive and durable sorbent. Results from sorbent preparation, bench-scale testing, and test data analysis are presented and discussed.

23340 (DOE/METC–89/6099, pp. 73-82) **Dynamic simulation models for high-temperature desulfurization processes-II.** Wang, J. (Louisiana State Univ., Baton Rouge (USA)); Cockrill, D.; Groves, F.R. Jr.; Harrison, D.P. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

Four models have been developed. Separate models describe sulfidation and regeneration of the fixed-bed reactor because different numerical solution techniques are required for each. A single model describes both the sulfidation and regeneration cycles in the fluidized- and moving-beds. Page limitations preclude mathematical development in this paper. Instead, the models are described qualitatively, input parameter requirements are defined, and example results presented.

23341 (DOE/METC–89/6099, pp. 83-94) **Side stream hot gas cleanup.** Lee, G.T. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The objectives of this study are to investigate process fundamentals of solid sorbents/reactants on the removal of contaminants from a sidestream of actual coal-derived gas and optimize contaminant removal efficiency sulfur species, tar, ammonia, and chlorides. Zinc ferrite, currently the prime candidate sorbent for hot gas desulfurization, has been extensively tested at METC in laboratory-scale and side stream units. The side stream unit serves as an intermediate or screening facility to confirm the results of laboratory-scale experiments and to provide data for scaleup. Most of the laboratory-scale experiments were carried out at low pressures using simulated gas, while the side stream testing emphasizes the use of real gas for the investigation of process fundamentals of solid sorbents on the removal of contaminants at actual operating conditions. The two-reactor system consists of two major reactors: a fluidized-bed and a fixed-bed reactor which allows testing of sorbent capabilities in two different contact modes

in a parallel arrangement. Also, it allows testing of absorption of different materials in a series configuration. Fabrication of the reactor system is described.

23342 (DOE/METC–89/6099, pp. 108-118) **Bench-scale testing of novel high-temperature desulfurization sorbents.** Harkins, S.M. (Research Triangle Institute, Research Triangle Park, NC (USA)); Gangwal, S.K. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The objectives of this contract are to perform bench-scale evaluation and preliminary engineering/economic assessment of novel high-temperature desulfurization sorbents which have shown potential for high-efficiency hydrogen sulfide removal down to 1 ppmv and/or stable operation at sulfidation temperatures greater than 1200 F. Four of these adsorbents and their abbreviated designations are: $(ZnO)_{0.86}(CuO)_{0.14}Fe_2O_3$-(ZC)F; $(ZnO)_{0.8}(TiO_2)$-(0.8Z)T; (3CuO) (Fe_2O_3) (Al_2O_3)-(C3)FA; and (CuO) (Al_2O_3)-CA. The highlights of results to date are as follows: The (0.8Z)T sorbent exhibited excellent durability over 5 cycles at 1350 F, was significantly simpler to regenerate than other sorbents and underwent very little sulfation during oxidative regeneration. The (ZC)F sorbent adsorbed an average of up to 15% sulfur by weight and was capable of reducing the H_2S to less than 1 ppmv over two cycles at 1100 F. The (C3)FA sorbent was capable of reducing the H_2S to less than 0.2 ppmv during the first sulfidation. Performance deteriorated during subsequent sulfidations, presumably because of incomplete regeneration. Disadvantages of the CA and (C3)FA sorbents include severe exothermicity due to CuO reduction, poor regenerability due to excessive sulfation, and significant loss of strength due to sulfate formation and decomposition. The CA sorbent also had a low average sulfur capacity.

23343 (DOE/METC–89/6099, pp. 119-124) **Reaction kinetics and simulation models for novel high-temperature desulfurization sorbents.** Woods, M.C. (Research Triangle Institute, Research Triangle Park, NC (USA)); Harrison, D.P.; Groves, F.R.; Jothimurugesan, K. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The objectives of this project are to investigate single pellet reaction kinetics of zinc ferrite and zinc titanate using a thermogravimetric reactor (TGR) at typical gasifier outlet conditions (1000 - 1400 F and 1-20 atmospheres) and to develop single pellet kinetic models based on the data. Contract options call for integral reactor models to be developed from the single pellet models. To date, the following items have been accomplished: Both the RTI and LSU thermogravimetric reactors have been modified to allow for additional pellets in the reactor tube besides the single pellet suspended from the hangdown wire. Both systems have been commissioned and sulfidation equivalency has been established between the two systems. Zinc vaporization and initial sulfidation tests have been completed on each of the four zinc titanate formulations and 1.5 $ZnO \cdot TiO_2$ has been selected for a detailed kinetic study. The pressure, temperature, and H_2S concentration dependencies of zinc ferrite (T-2465) sulfidation kinetics were measured using a KRW simulated gasifier gas. The intrinsic reaction activation energy and pseudo-rate constant were obtained for zinc ferrite (T-2465) sulfidation. Available results are discussed.

23344 (DOE/METC–89/6099, pp. 125-129) **Development of a hot gas clean-up system.** Anderson, G.L. (Institute of Gas Technology, Chicago, IL (USA)); Hill, A.H. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The overall objective of this project is to develop sorbents for removing sulfur-containing compounds and HCl from hot coal-derived fuel gas to less than 1 ppm(v) at operating temperatures between 1000 and 1200 F. These sorbents could be applicable to cleanup of fuel gases in both integrated coal gasification/molten carbonate fuel cell power plants and integrated coal gasification/combined-cycle power plants. The project includes five tasks in addition to program planning and final report preparation: (1) laboratory-scale studies to optimize the concentration of cobalt titanate in one of the sorbents used in the mixed metal oxide process; develop an oxygen-regenerable zinc oxide/zinc aluminate sorbent for the process; and explore the use of less costly molten carbonate mixtures in the IGT hot HCl removal sorbent, (2) design and construction of a skid-mounted 3000-SCF/h bench-scale hot gas cleanup process test system, (3) shipping the test system to METC for testing there, and (4) performing an engineering and economic assessment of the processes. Results to date are presented.

23345 (DOE/METC–89/6099, pp. 130-140) **Pore structure and reactivity changes in hot coal gas desulfurization sorbents.** Sotirchos, S.V. (Univ. of Rochester, NY (USA)). USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

During the past period, efforts have been concentrated on the development of a detailed simulation model for hot coal gas desulfurization in a fixed-bed reactor packed with pellets of metal oxide sorbents. Various structural models of distributed pore or grain size developed by this research group for studying gas-solid reactions with soiled product have been modified for application to metal oxide sulfidation. These models have been used to develop a detailed simulation model that can be used to study the transient phenomena that take place during desulfurization of coal gas in fixed-bed reactors loaded with pellets of metal oxide sorbents. The desulfurization model was applied to the analysis of the transient behavior of fixed-bed reactors loaded with pellets of zinc oxide. Particular emphasis was placed on the investigation of the effects of the structural model used for representation of the pore structure of the pellets, as well as of the effects of the structural characteristics of the porous solid (internal surface area, porosity, and pore size distribution), on the breakthrough behavior of the reactor and, hence, on the utilization of the sorbent. The developed desulfurization model is outlined, and some of the results obtained for fixed beds of zinc oxide pellets are presented and discussed.

23346 (DOE/METC–89/6099, pp. 141-147) **Calderon coal gasification process development unit design and test program.** Campbell, K. (Calderon Energy Company, Bowling Green, OH (USA)); Polen, K.; Calderon, A. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The process development unit (PDU) is designed to demonstrate the Calderon gasification process. In the process, run-of-mine high sulfur coal is first pyrolyzed to recover a rich gas (medium Btu gas), after which the resulting char is subjected to airblown gasification to yield a lean gas (low Btu gas). The process incorporates an integrated system of hot gas cleanup which removes both particulate and sulfur components of the gas products, and which cracks the rich gas to yield a syngas (CO and H_2 mix) suitable for further conversion (e.g., to methanol). The lean gas is suitable to fuel the combustion turbine of a combined cycle power generation plant. The PDU is sized to process 1 ton per hour of a high sulfur midwestern coal typical of that produced by Ohio mines. The rich and lean gas will be produced separately for the demonstration but will be combined during the test for disposal by flaring. The construction of the PDU will take place on property of Alliance Machine Co. in Alliance, Ohio.

23347 (DOE/METC–89/6099, pp. 160-166) **Sulfur kinetics studies.** Anderson, R.J.; Pham, H.; Grimm, U. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The objective of this study is to determine the potential role of calcium-based sorbents in controlling the release of sulfur from a number of both gasification and combustion systems. The research tasks involve surface science studies of the mechanisms and rates of the sulfur/calcium reactions, studies of sorbent preparation and characterization, laboratory-scale studies of sulfidation for both

fixed-bed and entrained-flow reactors, correlations of laboratory-scale and pilot-scale data, models of the reactors and sulfidation reactions, and studies of the formation of stable, disposable sulfur products. One aspect of the study has led to the development of a computer code which combines thermodynamic equilibrium and a one-dimensional gasifier model to describe METC's 42-inch stirred, fixed-bed gasifier. This code has been used to qualitatively predict the distribution of sulfur species throughout the gasifier which has limestone added to the coal feed at a calcium to sulfur ratio of 2. Preliminary calculations using the code indicate that conditions may exist in the gasifier which cause decomposition in the combustion zone of the sulfur captured by the sorbent in the upper portions of the gasifier. In addition, the model correctly predicts that some of the sorbent may react with the mineral components of the ash to form calcium-alumino-silicate compounds which do not effectively react with sulfur. Another part of the study involves the collection of experimental data sorbent utilization and reaction rate for conditions which simulate fossil energy processes. Tests have been initiated on an existing pressurized laboratory-scale entrained reactor which is capable of pressures up to 175 psig and temperatures up to 2700 F under either oxidizing or reducing conditions.

23348 (DOE/PC/88814–T4) **Fundamental studies of retrograde reactions in direct liquefaction: Fifth quarterly report, October 1–December 31, 1989.** Serio, M.A.; Solomon, P.R.; Kroo, E.; Charpenay, S.; Bassilakis, R. Advanced Fuel Research, Inc., East Hartford, CT (USA). [1990]. 47p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC88814. Order Number DE90008277. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The goal of this program is to elucidate and model the retrograde reaction chemistry in direct coal liquefaction through the application of experimental techniques and theoretical models to understand and predict coal reaction behavior. Retrograde reactions will be studied on three kinds of systems: (1) model polymers; (2) coal; and (3) modified coals. This quarter, the sample of C-C-C polymer (unsubstituted) was subjected to analysis by Py-FIMS and TG-FTIR; preparation of a low MW C-C-O polymer was started by the oxymercuration of 4-allylphenol in the presence of phenol; batch microautoclave liquefaction experiments for poly(eugenol) and poly (p-allylphenol) were done and the results were compared to those for a weakly linked (-O-C-) polymer and a sample of the Argonne Zap Lignite. FIMS and TG-FTIR analyses have now been done of samples of the ion-exchanged, methylated, and demineralized samples for each of the three coals: work began on using the AFR FG-DVC liquefaction model to simulate the results of the experiments on coals and modified coals from this program; liquefaction experiments were done on samples of dried, methylated, demineralized, and ion-exchanged Zap lignite coal in 50/50 dihydrophenanthrene/phenanthrene; and at a higher temperature and a shorter time on both raw and demineralized Zap and Wyodak coals. 15 refs., 21 figs., 7 tabs.

23349 (DOE/PC/88818–4) **Two-stage, close coupled catalytic liquefaction of coal: Fourth quarterly report, 1 July 1989–30 September 1989.** Comolli, A.G.; Johanson, E.S.; Panvelker, S.; Popper, G.A. Hydrocarbon Research, Inc., Lawrenceville, NJ (USA). Oct 1989. 23p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC88818. Order Number DE90008829. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

During this quarterly period microautoclave scale experiments were conducted on process modelling, catalyst and thermal slurry pretreatment. Gas yields of the various oil fractions were determined, higher yields being evident from the gas oil and resid. Higher conversions were obtained from pretreated coal slurry, particularly at >500°F. Data from the Variable Volume Bench Run CC-2 is presented, showing little advantage of this sequence (2X first stage) other than an unexpected improvement in denitrogenation accompanied by a higher hydrogen content of the product liquids with subbituminous Wyoming coal. An FeMo low density macropore catalyst was evaluated in a 12-day bench study and showed overall lower conversion on a volumetric catalyst basis than a NiMo catalyst. Some mechanical problems and a power failure delayed the start of a disperse catalyst evaluation run feeding Wyoming coal. Illinois No. 6 coal economics were updated to a 1988 basis. 10 figs., 6 tabs.

23350 (EUR–11401-EN) **Production of ammonia and town gas from lignite gasification (feasibility study).** Nitrogenous Fertilizers Industry S.A. (AEVAL), Athens (Greece). 1988. 17p. Available from Commission of the European Communities, Luxembourg.

The aim of this feasibility study was to examine the technical viability and economic feasibility of a lignite to ammonia/urea gasification complex with and without SNG production utilizing Greek lignites. The project was evaluated on a technical and economic basis and several alternatives were examined. The final proposed project configuration is as follows: (1) lignite gasification plant for the production of gas (LHV 3500 kcal/NCM) with a capacity of 83,000 NCM/h; (2) hydrogen separation unit (PSA) to separate hydrogen in the gas for use in ammonia production and enrich the off-gas stream in methane; (3) ammonia production plant with a capacity of 382,000 MT/y; (4) urea production plant with a capacity of 328,500 MT/y; and (5) steam and power plant. The lignite feedstock is of low grade (high ash and moisture content). Nitrogenous Fertilizers Industry SA has decided to proceed with the realization of the project provided a grant is obtained under Greece's investment incentive laws. The total invested capital for the overall complex is USD 468 million with an ammonia production cost of USD 165/MT.

23351 (PB–90-141219/XAB) **Zeolite-supported catalysts. Report for August 1986-November 1987.** Chien, S.H. Academia Sinica, Taipei (Taiwan). 1988. 38p. Available from NTIS, PC EE04/MF E04.

The present paper is a comparative study of the cerium-containing nickel catalysts supported on x- and y-zeolites. In general, the addition of cerium ions caused an increase in the catalytic activity for CO hydrogenation and shifted the product selectivity to high molecular weight hydrocarbons. The degree of the effect of cerium additive depends on the ratio of cerium to nickel contents, the reduction temperature, and the nature of the supporting materials. Catalyst characterization, including volumetric hydrogen chemisorption, temperature programmed reduction/desorption, x-ray diffraction, surface area measurements, in-situ infrared spectroscopy and x-ray photoelectron spectroscopy, was performed in order to interpret the phenomena due to the effects of cerium additives and the support effect on Ni/zeolite catalysts.

23352 **Production of coal-solubilizing activity by Paecilomyces Sp. during submerged growth in defined liquid media.** Faison, B.D. (Oak Ridge National Laboratory, Oak Ridge, TN (USA)); Lewis, S.N. *Applied Biochemistry and Biotechnology (USA),* 20/21: 743-752 (Jan-Aug 1989). (CONF-880521–: 10. symposium on biotechnology for fuels and chemicals, Gatlinburg, TN (USA), 16-20 May 1988).

Paecilomyces TLi, a fungus isolated from coal, had previously been shown to transform solid coal into a water-miscible liquid during surface growth on coal or on a complex, solid microbiological medium. Coal solubilization has now been demonstrated in submerged cultures grown in defined liquid minimal media. Activity under these conditions is less than that observed in surface culture, and is affected by both nitrogen and carbon nutrition. Coal solubilization occurs at low pH (<4) but may be associated with pH increases during the assay period. Spectroscopic data suggest a role for alkaline catalysis in coal solubilization by this organism. 9 refs., 3 figs., 6 tabs.

23353 **Evidence that microbially produced alkaline materials are involved in coal biosolubilization.** Quigley, D.R. (Idaho National Engineering Laboratory, Idaho, NE (USA). Center for Bioprocessing Technology and Biotechnology Group); Ward, B.; Crawford, D.L.; Hatcher, H.J.; Dugan, P.R. *Applied Biochemistry and Biotechnology (USA),* 20/21: 753-763 (Jan-Aug 1989). (CONF-880521–: 10. symposium on biotechnology for fuels and chemicals, Gatlinburg, TN (USA), 16-20 May 1988).

The biosolubilities (susceptibility to being attacked and solubilized by microbes) of 17 coals by 9 microbes were evaluated, as were solubilities of these coals in dilute alkaline buffers. A direct relationship between coal alkali- and biosolubilities was observed suggesting a common mechanism of coal solubilization. These data are consistent with the hypothesis that a mechanism by which

microorganisms solubilize coal is by production of alkaline materials that raise medium pH and effect solubilization. 19 refs., 5 figs., 3 tabs.

0105 Products and By-Products

Refer also to citation(s) 23258, 23264, 23319, 23321, 23322, 23324, 23350, 23417

0106 Properties and Composition

Refer also to citation(s) 23295, 23305, 23310, 23348, 23361, 23399, 23401, 23402, 23421, 23515, 23537, 23538, 23639, 24037

23354 (DOE/METC–88/6092-Vol.1, pp. 224-227) **Laser-induced breakdown spectroscopy (LIBS) for the analysis of combustor/gasifier streams.** Chisholm, W.P. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

Experience with coal-fired gasifiers and combustors has shown that the presence of trace elements in the process stream can adversely affect system performance. For example, vanadium, lead, chlorine, and the alkali elements can corrode metal components. In addition, the presence of other metals (e.g. mercury and cadmium), in coal-derived fuel or exhaust streams could make a conversion process unacceptible from an environmental point of view. The primary objective of this research is to develop a routine, real-time, in situ analysis system based on laser-induced breakdown spectroscopy (LIBS), applicable to high temperature, high pressure process streams. Experimental work on LIBS at present has been applied to laboratory aerosols generated by nebulization of salt solutions. Major accomplishments to date have been verification of the usefulness of the internal standard method of quantitation. Spectra of chromium and magnesium ions near 2800 Angstroms have been acquired at fixed magnesium concentration and varying chromium concentrations in the aerosol. Ratios of integrated emission line intensities displayed improved analytical utility as compared to absolute intensities. Similar improvements were noted when using ratios involving an emission line from the aerosol and emission line from nitrogen, a constituent of the carrier gas. The effects of varying composition of the carrier gas have also been explored.

23355 (DOE/PETC/TR–90/1) **Status of the characterization of jet fuels from coal liquids.** Pukanic, G.W.; Perry, M.B.; Ruether, J.A.; Schmidt, C.E. USDOE Pittsburgh Energy Technology Center, PA (USA). Jan 1990. 32p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90007162. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The present report will compare results of analyses and correlations of properties carried out on samples of high-density fuels from the integrated two stage liquefaction (ITSL) process. These samples were produced at Chevron. We will also describe in part those investigations carried out on GPGP tar oil. 43 refs., 14 tabs.

23356 (DOE/PETC/TR–90/2) **Application of surface and bulk characterization techniques for coal preparation.** Gala, H.B. (Burns and Roe Services Corp., Pittsburgh, PA (USA)); Hucko, R.E. USDOE Pittsburgh Energy Technology Center, PA (USA). Jan 1990. 104p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90007161. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

With the recent acceleration of development of surface-property-based processes for the beneficiation of ultrafine coal, it is essential to establish their underlying scientific principles and to develop mathematical models able to predict how the process will perform on an unknown coal. Various surface properties of importance, surface characterization techniques, and application of these techniques to coal are reviewed. Instrumental techniques used for analyzing bulk composition of organic and/or inorganic matter are also reviewed. The differences in coal and mineral matter properties are highlighted. The effect of particle history, including grinding and oxidation, on the surface properties of coal is discussed. The mechanisms of advanced physical beneficiation processes are reviewed, and the influence of surface properties on the effectiveness of separation between coal and the liberated mineral matter is discussed. Finally, recommendations for future areas of research are made. 121 refs., 19 figs., 17 tabs.

23357 (ERP/CRL–88-65(OP)) **Categorization of Western Canadian coals with respect to their susceptibility to spontaneous combustion.** Chakravorty, R.N.; Kar, K.; Mansour, N. Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Coal Research Lab. Sep 1988. 30p. Available from Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Coal Research Lab.

An examination of commonly used methods for spontaneous combustion characterization of coals was carried out. The more common of these included: (1) determination of initial temperature, (2) adiabatic calorimetry, (3) differential thermal analysis, and (4) determination of crossing point temperature. 7 refs., 7 figs., 9 tabs.

23358 (ERP/CRL–88-74(TR)) **A CERCHAR hardness test program methodology developed for the Sydney Coalfield, N.S.** Musial, M.L.; Corbett, G.R.; Aston, T.R.C. Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Coal Research Labs. Nov 1988. 20p. Available from Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Coal Research Lab.

CERCHAR (France) has developed a test by which rock cuttability (hardness and abrasivity) can be predicted. This paper details test procedures conducted at the Cape Breton Coal Research Laboratory to establish a rock hardness index system/database for use in the Sydney Coalfield, Nova Scotia. 5 figs., 3 tabs., 5 figs., 2 append.

23359 (TNO-HMT–86-259) **Characterisation of ashes from the TNO 4MWth coal fired fluidised bed boiler.** Haasteren, A.W.M.B. van. Nijverheidsorganisatie TNO, Apeldoorn (Netherlands). Aug 1986. 51p. Available from TNO, PO Box 342, 7300 AH, Apeldoorn, Netherlands.

The residue from fluidised coal combustion, during which limestone is added to reduce the sulphur dioxide emissions, is ash. This ash, in most cases fly ash as well as bed ash, has to be processed during the combustion process and disposed of. Proper design of the separation and the ash transport equipment, as well as the decision as to how to dispose of the ash, requires extensive physical and chemical characterisation of the ash. The main components of the ash are unburned char, Al_2O_3, SiO_2, Fe_2O_3 FeS and - from the limestone addition - CaO, $CaSO_4$ and $CaCO_3$. Trace elements originating from the coal and limestone are found in various concentrations in the bed ash and the fly ash. Particle size distributions of bed ash can be used to calculate fluidisation and heat transfer characteristics; particle size distributions of the cyclone and filter ashes are required in designing the cyclones and/or filters. During experiment 180, the TNO atmospheric fluidised bed burner (AFBB) was operated at 'AKZO' conditions: bed temperature 850°C; combustion efficiency 98.5% and SO2 emissions 230 g/GJ. A complete characterisation of the discharged fly ash and bed ash is given with regard to chemical composition, trace elements and particle size distribution. For an experimental fluidised bed boiler, the samples taken and the measurements done can only be regarded as representative for the used coal and limestone and the specified boiler conditions if the boiler is in a steady state. It was found that after an extreme change in boiler conditions (change of coal type, limestone type, bed height, bed temperature) the time needed to reach a new steady state may amount to more than 200 (operating) hours, independent of boiler size.

0108 Waste Management

Refer also to citation(s) 23275, 23287, 23288, 23295, 23329, 23330, 23337, 23340, 23347, 23359, 23376, 23377, 23419, 23453, 23716, 23717, 24362

23360 (BG-MRS-E-564) **The BGL gasifier: recent environmental results.** Ebbins, J.R.; Ruhl, E. British Gas PLC, Solihull (UK). Midlands Research Station. Oct 1989. 28p. (CONF-8810105--: 8. annual EPRI conference on coal gasification, Palo Alto, CA (USA), 19-20 Oct 1988). Available from British Gas plc, Solihull (UK). Research and Technology Division, Midlands Research Station.

Operation of the British Gas/Lurgi (BGL) Gasifier gives rise to an aqueous liquor which must be upgraded prior to reuse or if necessary, discharged to the environment. The major components in the liquor arising from the gasification of Pittsburgh 8 coal within the BGL Gasifier have been determined to be ammonia 7,700 mg/l, phenols 5,400 mg/l, chloride 1,250 mg/l with a Chemical Oxygen Demand (COD) of 19,750 mg/l. Conventional treatment consists of dephenolation by solvent extraction, dissolved gas stripping, biological treatment by the activated sludge process followed by activated carbon treatment. The British Gas liquor treatment pilot plant at Westfield, Scotland treated Pittsburgh 8 liquor over a 75 day period. The treated liquor produced was colourless and had a very low residual total organic carbon content and chemical oxygen demand. The use of reverse osmosis as a treatment stage was demonstrated at the laboratory scale. Combining reverse osmosis with biological treatment, produced a high quality, near potable standard, chloride free water. An alternative to conventional treatment is incineration and a proprietary, commercially available incineration process by Lurgi is described. Chlorides in the liquor are removed by this process as a solid residue. A pilot scale facility for demonstration and optimisation of the process is available at Lurgi's R&D Centre in Frankfurst. Iron removal and leaching tests have also been carried out on the slag arising from the gasification of Pittsburgh 8 coal. These tests have demonstrated that slag is not a hazardous waste as defined by the US Resource Conservation and Recovery Acts and does not present an environmental problem. 4 refs., 3 figs., 13 tabs.

23361 (BG-MRS-E-571) **The fate of trace elements in the BGL gasifier.** Beishon, D.S.; Hood, J.; Vierrath, H.E. British Gas PLC, Solihull (UK). Midlands Research Station. Dec 1989. 14p. (CONF-890916--: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989). Available from British Gas plc, Solihull (UK). Research and Technology Division, Midlands Research Station.

Coal contains a very large number of trace elements and knowledge of the fate of some of these elements during gasification is vital for environmental protection. The analysis of coal and flux used by the BGL gasifier at Westfield and the slag, liquor and gas produced, for minor and trace elements is reported. The BGL gasifier produces a medium BTU fuel gas at high efficiency. The coal ash is converted to a glassy, inert slag that contains most of the trace elements of environmental concern. The slag is highly resistant to leaching and is suitable for landfill. Aqueous liquor can be treated to meet stringent environmental standards and the only waste product requiring special disposal procedures is a small amount of salt-cake arising from the chloride in the coal. Three techniques have been used for the analysis of trace elements: atomic absorption spectrometry; neutron activation analysis; and inductively coupled plasma atomic emission spectroscopy. The relative merits of the analytical techniques are discussed. 5 refs., 2 figs., 8 tabs.

23362 (CONF-860903-5) **Combined removal of SO_2 and fly ash from simulated flue gas using pulsed streamer corona.** Clements, J.S.; Mizuno, A.; Finney, W.C.; Davis, R.H. Florida State Univ., Tallahassee, FL (USA). Dept. of Physics. [1986]. 33p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-86PC91021. From IEEE-Industry Applications Society annual meeting; Denver, CO (USA); 28 Sep - 2 oct 1986. Order Number DE90008850. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A pulse-energized electron reactor (PEER) which utilizes pulsed streamer corona has been developed for the combined removal of SO_2, NO_x, and particles from effluent gases. In the PEER process, fast-rising, narrow, high voltage pulses are superimposed on a dc-bias voltage and applied to a non-uniform electric field geometry to generate pulsed streamer corona. The pulsed streamer corona produces energetic free electrons which dissociate gas molecules, forming radicals. These radicals cause chemical reactions that convert SO_2 and NO_x into acid mists and/or solids which can be removed from the gas stream by conventional means. The pulsed streamer corona also produces ions, and between pulses the ions charge the fly ash particles which are then collected by the dc-bias field. In PEER performance tests on a humid air stream with an initial SO_2 concentration of 1000 ppm, more than 90% of the SO_2 was removed with an advantageously small power requirement. Combined treatment performance was demonstrated by introducing high resistivity fly ash into the gas stream. 16 refs., 9 figs., 1 tab.

23363 (DOE/METC-88/6092-Vol.1, pp. 228-232) **Throwaway processes for treatment of regeneration tail gases.** Bodek, I. (Arthur D. Little, Inc., Cambridge, MA (USA)); Woodland, L.R. US-DOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544--: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The goal of this program is to evaluate processes for treating the regeneration tail gas from a high-temperature desulfurization process (zinc-ferrite process) used in coal gasification applications. METC has sponsored the development of an elemental sulfur recovery process which has proven to be technically practical, but appears economically unattractive. The primary objective of this test program is the demonstration on a bench-scale of an energy-efficient, non-recovery process that can treat this offgas stream, while producing environmentally acceptable waste products. A second objective of this test program is to collect sufficient data to allow incorporation of the test results into a conceptual full-scale design for comparing the economics of the non-recovery processes with the recovery processes under development. The two throwaway processes which have been investigated on a bench-scale for desulfurization of the zinc-ferrite regeneration tail gas are: (1) dual-alkali wet scrubbing; and (2) spray dryer flue gas desulfurization (FGD). The dual-alkali absorption system achieved greater than the necessary 99.92% SO_2 removal efficiency to reduce the regeneration tail gas concentrations of up to 120,000 ppm in the scrubber inlet to outlet SO_2 concentrations of less than 100 ppm. In the spray dryer FGD testing, a maximum SO_2 removal efficiency of 99.3% was achieved (in a single stage). Although this testing indicates that spray dryer FGD treatment of the zinc-ferrite reactor tail gas combined with bag filter particulate collection may be able to meet the required FGD system outlet. SO_2 concentration of less than 100 ppm at the higher inlet temperature (1500F) and SO_2 concentration (30,000 ppm), it would require operation so close to outlet saturation temperature (2-5F) as to make the process very difficult to operate.

23364 (DOE/METC-88/6092-Vol.1, pp. 240-246) **Sorbent-based recovery of sulfur from regeneration tail gases.** Harkins, S.M. (Research Triangle Institute, Research Triangle Park, NC (USA)); Gangwal, S.K. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544--: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

This project is to develop two novel process concepts leading to the production of elemental sulfur from hot gas desulfurization off-gases. Both concepts utilize a highly efficient regenerable sodium/aluminum (Na/Al) sorbent at high temperature and pressure. The first concept utilizes the sorbent for conversion of hot gas desulfurization off-gases containing approximately 2.0% SO_2 to a suitable Claus plant inlet gas containing 10 to 50% H_2S at high pressure and temperature. The second concept attempts to produce sulfur in a single step process by reacting the off-gas with a small quantity of reducing gas over the sorbent. Results to date are as follows. (1) The technical feasibility of a process concept for sorbent based recovery of elemental sulfur from regeneration off-gases has been demonstrated. (2) A Na/Al sorbent was demonstrated to adsorb up to 40% by weight SO_2 at 700C and could be regenerated through multiple cycles with reducing gas to produce a

H_2S rich gas containing up to 60% H_2S. (3) The sorbent preparation conditions were investigated in detail and optimized. Several sorbent formulations were prepared and screened using 20-cycle TGA runs. Promising sorbent formulations were selected for further study at elevated pressures. (4) Sorbent sulfation and regeneration kinetics were measured using a high pressure TGA. Pressure and SO_2 concentrations were shown to significantly enhance the sorbent sulfation rate and capacity.

23365 (DOE/METC–88/6092-Vol.1, pp. 304-308) **NO_x-char reactions: Kinetics and transport aspects.** Calo, J.M. (Brown Univ., Providence, RI (USA)); Suuberg, E.M. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The study of NO_x-char reaction systems will be conducted in two phases. Phase I involves the characterization of the chars with respect to structure and composition. The interaction of NO and co-adsorbates will be examined in a TGA system. The desorbed gases from these experiments will be examined to determine the resultant product gas composition upon desorption. Finally, the char surfaces will be doped with co-adsorbates suspected of playing a role in the NO-char reaction mechanism in order to assess whether these species inhibit the reaction and/or whether NO reduction occurs on the same sites or other sets of sites than those occupied by the co-adsorbent gases. Diffuse reflectance infrared spectroscopy will be tried in order to ascertain the nature of adsorbed surface oxides from NO alone, and in the presence of co-adsorbates. Phase II involves kinetics studies of the NO-char reaction system, which initially will be carried out thermogravimetrically as an extension of the characterization process in the TGA system. This will include steady-state kinetics measurements to determine global reaction rate orders and activation energies for the chars used. However, model discrimination between mechanisms and the measurement of individual rate constants will be done subsequently using a transient kinetics apparatus that has been developed expressly for the study of gasification reactions. Since it is anticipated that diffusion may play an important role the intraparticle transport characteristics of NO in the various chars used will be measured using a new transient method. Results to date are discussed.

23366 (DOE/METC–88/6092-Vol.1, pp. 333-341) **Experimental and theoretical investigation of the formation and growth of ash agglomerates.** Carty, R.H. (Institute of Gas Technology, Chicago, IL (USA)); Rehmat, A. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The objectives of this work are to obtain the experimental data and perform the data analysis required to determine the behavior of coal mineral matter in a fluidized-bed gasifier using limestone as a sulfur capture agent and to correlate the formation of ash agglomerates in an agglomerating fluidized-bed coal gasifier with the gasifier configuration and operating conditions and the physical and chemical characteristics of the mineral constituents. In addition, a theoretical investigation of the agglomeration mechanism from first principles will be used to develop the governing mathematical relationships. The accomplishments of this program to date include: Examination of bed material from fluidized-bed coal gasification tests using limestone as an in-bed sulfur capture agent show that coal ash deposits on the surface of particles of limestone-derived material and tends to migrate into the particles. There were very few conventional ash agglomerates composed solely of coal mineral matter formed in these tests. Although there was little evidence that the surface coating of reaction product of coal ash and limestone-derived material causes extensive adhesion of these particles, it is possible that it could block the pores of the particles to prevent reaction. The temperature profiles in the jet region of a fluidized-bed of polyolefin beads were measured and correlated with the temperatures and velocities of the jet and fluidizing gases. Based on these measured temperature profiles of the jet region, an equation to calculate the rate of agglomeration as a function of time, temperature and gas velocities was developed.

23367 (DOE/METC–88/6092-Vol.1, pp. 396-406) **Advanced wastewater treatment.** Gallagher, J.R. (Energy and Mineral Research Center, Grand Forks, ND (USA)); Turner, C. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The principal objective is to expand the scientific and engineering data base on the treatment of gasification wastewater. Efforts are focused on novel methods to achieve the following: (1) combined carbon oxidation/nitrogen removal, and (2) a high-rate biological oxidation reactor. A third effort will examine pretreatment requirements for the discharge of gasification effluents to publicly-owned treatment works. A fluidized bed biological reactor and a pure oxygen, plug flow biological reactor were designed and constructed. Results of testing the fluidized bed reactor are given and discussed. Preliminary results are also given for tests of the second reactor.

23368 (DOE/METC–88/6092-Vol.2, pp. 525-531) **A membrane-based process for flue-gas desulfurization.** Radovich, J.M. (Bend Research, Inc., Bend, OR (USA)). USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

Bend Research, Inc., has developed a membrane-based technology that replaces packed towers or conventional scrubbing systems for the removal of SO_2 from the flue gas of coal-fired power plants. The technology uses a membrane contactor to contact the flue gas with the liquid absorbent that removes SO_2. A membrane contactor is a separation device in which two phases are separated by an SO_2-permeable polymeric membrane. In this application, the membrane is a microporous, hydrophobic material. The SO_2 passes through the gas-filled micropores into the flowing solution, where it is absorbed and removed by reacting with sodium sulfite. Any suitable solution can be used as the absorbent for SO_2 in the membrane contactor. For development work, the authors chose sodium sulfite–the solution that is used in the Dual-Alkali and Wellman-Lord flue-gas FGD processes. A field-test unit was constructed. It contains four membrane modules, each with 30 ft^2 of membrane area. This test unit can process up to 200 SCFM of flue gas at a maximum temperature of 170 F. In the field tests at Pacific Power and Light's power plant in Centralia, Washington, at least 85% of the SO_2 in the flue gas was removed.

23369 (DOE/METC–88/6094, pp. 295-304) **Super-equilibrium sulfur removal from high temperature gases.** Chatwani, A.U. (Avco Research Laboratory, Inc., Everett, MA (USA)); Stickler, D.B. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The objective of this program is to investigate the potential of chemical sorbents for sulfur removal from high temperature gases (1600-2400 K) under transient thermal nonequilibrium conditions. The scope of this work is to determine, from single pulse experiments, the effects of various sorbent properties and coal combustion conditions on sulfur capture. A single pulse batch reactor is used to simulate the conditions of sorbent particle injection into hot sulfur containing gases. A transient jet stirred reactor flow is used to disperse solid sorbent particles in a selected background combustible gas containing a known amount of hydrogen sulfide. Heating is accomplished by ignition of the combustible gas mixture.

As it is postulated that the particle temperature plays a very important role in determining the sulfur capture, a task was undertaken was to monitor the solids transient temperature. An optical multichannel analyzer is used to follow the particles temperature by measuring the spectral emissions from the solids as they heat up in the background gas. The effects of adiabatic gas temperature, sorbent particle size, sorbent-to-sulfur ratio, and process stoichiometry on the transient sulfur capture are being studied. In addition to limestone, the following sorbents are being investigated: calcium oxide, pressure hydrated lime, and an inert solid. The test plan also includes modeling support to determine kinetic constants for sulfur capture reactions. Results on transient particle temperature measurements and sulfur capture (rapid sampling and continuous monitoring of SO_2) are discussed.

23370 (DOE/METC–89/6099, pp. 148-152) **Throwaway processes for treatment of regeneration tail gases.** Bodek, I. (Arthur D. Little, Inc., Cambridge, MA (USA)); Woodland, L.R. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The goal of this program is to evaluate processes for treating the regeneration tail gas from a high-temperature desulfurization process (zinc-ferrite process) used in coal gasification applications. METC has sponsored the development of an elemental sulfur recovery process which has proven to be technically practical, but appears economically unattractive. The primary objective of this test program is the demonstration on a bench-scale of an energy-efficient, non-recovery process that can treat this offgas stream, while producing environmentally acceptable waste products. A second objective of this test program is to collect sufficient data to allow incorporation of the test results into a conceptual full-scale design for comparing the economics of the non-recovery processes with the recovery processes under development. The two throwaway processes investigated on a bench-scale for desulfurization of the zinc-ferrite regeneration tail gas are: (1) dual-alkali wet scrubbing; and (2) spray dryer flue gas desulfurization (FGD). The dual-alkali absorption system achieved greater than the necessary 99.92% SO_2 removal efficiency to reduce the regeneration tail gas concentrations of up to 120,000 ppm in the scrubber inlet to outlet SO_2 concentrations of less than 100 ppm. In the spray dryer FGD testing, a maximum SO_2 removal efficiency of 99.3% was achieved (in a single stage). Although this testing indicates that spray dryer FGD treatment of the zinc-ferrite reactor tail gas combined with bag filter particulate collection may be able to meet the required FGD system outlet SO_2 concentration of less than 100 ppm at the higher inlet temperature (1500 F) and SO_2 concentration (30,000 ppm), it would require operation so close to outlet saturation temperatures (2-5 F) as to make the process very difficult to operate.

23371 (DOE/METC–89/6099, pp. 153-159) **Sorbent-based recovery of sulfur from regeneration tail gases.** Harkins, S.M. (Research Triangle Institute, Research Triangle Park, NC (USA)); Gangwal, S.K. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

This project is to develop two novel process concepts leading to the production of elemental sulfur from hot gas desulfurization offgases. Both concepts utilize a highly efficient regenerable sodium/aluminum (Na/Al) sorbent at high temperature and pressure. The first concept utilizes the sorbent for conversion of hot gas desulfurization off-gases containing approximately 2.0% SO_2 to a suitable Claus plant inlet gas containing 10 to 50% H_2S at high pressure and temperature. The second concept attempts to produce sulfur in a single step process by reacting the off-gas with a small quantity of reducing gas over the sorbent. The technical feasibility of a process concept for sorbent based recovery of elemental sulfur from regeneration off-gases has been demonstrated. A Na/Al sorbent was demonstrated to adsorb up to 40% by weight SO_2 at 700 C and could be regenerated through multiple cycles with reducing gas to produce a H_2S rich gas containing up to 60%. The sorbent preparation conditions were investigated in detail and optimized. Several sorbent formulations were prepared and screened using 20-cycle TGA runs. Promising sorbent formulations were selected for further study at elevated pressures. Sorbent sulfation and regeneration kinetics were measured using a high pressure TGA. Pressure and SO_2 concentrations were shown to significantly enhance the sorbent sulfation rate and capacity.

23372 (DOE/PC/89805–T1) **Cross-flow, filter-sorbent catalyst for particulate, SO_2 and NO_x control: Technical progress report.** Little (Arthur D.), Inc., Cambridge, MA (USA). Mar 1990. 25p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-89PC89805. (ADL–64303). Order Number DE90008856. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objective of this program is to successfully carry out the experiment and design tasks described herein that will lead to the development a single-unit, cross flow filter-sorbent-catalyst. In the first stage of work we will investigate the SO_2 removal and NO_x reduction characteristics of different sorbent-catalyst compositions (in granular form), and we will conduct exploratory tests of cross-flow filters under conditions similar to those found in the combustion gases of small-scale combustors. In the second stage of the program, we will investigate the pollutant control characteristics of prototype filter-catalyst devices. The SO_2 removal and NO_x reduction efficiency of a 'unit-element' prototype will be investigated. This 'unit element' will be a slot reactor comprised of two flat porous walls, or 'slabs' of filter-sorbent-catalyst material separated by a 0.5 centimeter gap. The particulate collection efficiency and backflushing requirements of a multi-element version of this device will be tested. A sorbent regeneration scheme will also be investigated. The sorbents under evaluation are: CuO, CeO_2, CuO-Al_2O_3, CeO_2-Al_2O_3, CuO-CeO_2, and CuO-CeO_2-Al_2O_3. Progress is described. 25 refs., 4 figs., 5 tabs.

23373 (TNO-HMT–88-032) **Quality improvement of AFBB flyashes by separation.** Mulder, E. Nijverheidsorganisatie TNO, Apeldoorn (Netherlands). Jan 1988. 74p. (In Dutch). Available from TNO, PO Box 342, 7300 AH, Apeldoorn, Netherlands.

The aim of the project described in this report was to investigate the possibility of concentrating the unburned coal and the calcium components present in atmospheric fluidised bed boiler (AFBB) fly ashes, in one or two fractions, by means of separation, leaving one fraction free of coal and lime. Preliminary experiments have shown that this is best achieved by classification rather than sieving. On a laboratory scale, separation by means of classifying twice yields a coarse fraction containing coal (4%), calcium oxide (16%), calcium sulphate (19%) and minerals (61%), a medium fraction composed of 23%, 11%, 11% and 55% of these components respectively, and a fine fraction made up of 5% coal, 7% calcium oxide, 8% calcium sulphate and 80% minerals. The medium fraction, which contains the highest percentage of coal, can be recirculated, while the others are discarded. Scaling up the process should be possible, as experiments on a semi-technical and technical scale have yielded results comparable with those obtained at the laboratory scale. Such a classifier could either be added as an extension to an AFBB installation, or integrated into the installation itself. In both cases, the combustion efficiency of the AFBB installation would increase, because of the selective recirculation of unburned coal.

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Refer also to citation(s) 23405, 23439, 23448

23374 (AD-A–215075/3/XAB) **Evaluation of water quality in Barkley Lake and embayments with the BETTER-2D model. Final report, February 1988-August 1989.** Brown, R.T. Tennessee Technological Univ., Cookeville, TN (USA). Water Resources Center. Aug 1989. 251p. Available from NTIS, PC A12/MF A02.

BETTER, a two-dimensional mathematical water quality model, was used to simulate water quality conditions in the main-stem and two embayments of Lake Barkley. Sources and preparation of input data including reservoir and outlet geometry, meteorological conditions, model coefficients and inflow quality and quantity, are described. The report also outlines revisions to the model for the Barkley application, and calibration and verification procedures. Three years, 1984-1986, were simulated under observed conditions and model predictions were compared to observed data.

Additional computerized simulations were performed to estimate impacts on water quality resulting from summer storm events, increased loadings of organic materials and nutrients, and the Cumberland Steam Plant. Knowledge gained from simulations with the model is summarized and recommendations for future applications and field studies are made.

23375 (DOE/EA–0404) **Innovative Clean Coal Technology Program: Coke oven gas cleaning demonstration project, Bethlehem Steel Corporation Sparrows Point Plant, Baltimore County, Maryland: Environmental Assessment.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Dec 1989. 63p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90008995. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This Assessment has been prepared by the US Department of Energy (DOE) to evaluate environmental issues associated with a project that will be cost-shared by DOE and private industry under the Innovative Clean Coal Technology Program. The proposed action is a coke oven gas cleaning technology demonstration project proposed to be installed and operated at the Bethlehem Steel Corporation, Sparrows Point Plant, in Baltimore County, Maryland. Alternatives to the proposed action, which include no action, delayed action, and the use of alternate sites or technologies, are discussed. Three basic steel manufacturing operations are carried out at the Sparrows Point Plant: (1) pyrolytic conversion of coal to coke (carbon) in coke ovens; (2) combination of coke, iron ore, and limestone in a blast furnace to produce iron; and (3) refinement of iron to steel in oxygen or open-hearth furnaces. The Coke Works at the plant consists of three operational coke batteries and two Coal Chemicals plants. Bituminous coal is heated in a coke oven in the absence of air to remove its volatile components. About 70% of the coal feed is converted to coke; the remaining 30% consists of by-product gases and vapors. These by-product gases are treated in the Coal Chemicals plants to recover usable and marketable products, including coke oven gas, which is used to fuel the ovens and furnaces within the plant. The analysis concluded that no significant, environmental impacts would result from the proposed project. 12 refs., 11 figs., 10 tabs.

23376 (DOE/EA–0405) **Innovative sulfur dioxide scrubbing system for coal-burning cement kilns: Environmental assessment.** Department of Energy, Washington, DC (USA). Assistant Secretary for Fossil Energy; Passamaquoddy Tribe, Princeton, ME (USA). Mar 1990. 42p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90008989. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The proposed action is intended to demonstrate the successful application of a practical, cost-effective method to control SO_2 emissions that could be used by the US cement-making industry to achieve compliance with environmental standards without replacing existing cement-making facilities. The demonstration has been scaled to generate data from design, construction, and operation sufficient to enable private industry to assess the potential for commercial application of the technology.The proposed project will reduce emissions of atmospheric pollutants; eliminate waste dust production; produce high purity wastewater; and produce a by-product (potassium sulfate) which, when sold as a component of fertilizer, will achieve some level of cost recovery. The proposed process uses the waste dust in a slurry form to scrub the kiln exhaust gas for the removal of sulfur dioxide and, possibly, nitrogen oxides. In addition, the waste kiln dust would then be suitable as kiln feed raw material because the alkali metals are dissolved, reacted, and removed. The process produces two major by-products, solid material rich in potassium sulfate, and distilled water. The potassium sulfate will be sold as a fertilizer component. 7 refs.

23377 (DOE/FE–0164) **A fossil energy perspective on global climate change.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of Planning and Environment. Jan 1990. 99p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90007894. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This report discusses global climates change from a fossil energy power generation perspective. As such, it highlights the substantial uncertainties that underlie the forecasts of GHG emissions, GHG concentrations, and climate change–forecasts that some believe provide the basis for current initiatives to reduce or eliminate fossil fuel use. In addition, this report demonstrates that if it is determined that GHG emissions should be reduced, fossil-fuel-based technologies must play a role in this process. 136 refs., 45 figs., 11 tabs.

23378 (DOE/METC–88/6092-Vol.1, pp. 407-414) **Environmental engineering and analysis.** Page, G.C. (Radian Corporation, Austin, TX (USA)); Skinner, F.D.; Raden, D.P. US-DOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The primary objective of this project is to obtain and evaluate environmental data for advanced synthetic fuel technologies and associated pollution controls (i.e., gas cleanup and wastewater treatment). A number of synfuels technologies have received or are currently receiving support from METC, including the Mountain Fuel Resources and KRW gasification technologies, and several raw gas and aqueous waste cleanup technologies. Activities within the present project are designed to obtain and evaluate environmental, health, and safety (EH&S) and process data for these and other synfuels technologies of interest to DOE. The Environmental Engineering and Analysis Project has been organized into three separate task areas: (1) Environmental, health, and safety program plan implementation; (2) site sampling and analysis; and (3) engineering analysis of pilot-, PDU-, and commercial-scale data. Each task is described and results from each to date are present. Task 1 has been completed; tasks 2 and 3 are still underway.

23379 (ERP/CRL–88-69(J)) **Longwall seafloor subsidence monitoring: how and why.** Aston, T.R.C. Canada Centre for Mineral and Energy Technology, Sydney, NS (Canada). Cape Breton Coal Research Lab. Oct 1988. 14p. Available from Canada Centre for Mineral and Energy Technology, Sydney, NS (Canada). Cape Breton Coal Research Lab.

This paper discusses the need for guidelines for monitoring of longwall subsidence in undersea mining operations. A research program implemented at the Sydney Coalfield, Nova Scotia is reviewed. To date, marine geophysical techniques appear to be the most effective method of identifying seafloor subsidence profiles through the comparison of pre- and post-mining seafloor topographies. 6 refs., 3 figs.

23380 (PB–90-135435/XAB) **Quality of water and bottom material of streams that drain potential lignite mining areas in the outcrop area of the Wilcox Group in Mississippi. Water Resources Investigation.** Kalkhoff, S.J. Geological Survey, Jackson, MS (USA). Water Resources Div. 1989. 42p. (USGS/WRI–86-4345). Available from NTIS, PC A03/MF A01.

In order to assess the effect of strip mining of lignite in Mississippi, there is a need for background data on quality of water and bottom material in streams that drain potential mining areas. The report presents the results of the chemical analyses of samples and describes the relations between various physical and chemical characteristics of the water and bottom materials in these streams. Relations between these constituents may be expected to change with the onset of mining activities and thus may be used to assess the effect of mining activities on stream water quality.

23381 (PB–90-137969/XAB) **Health assessment for Pine Street Canal Site, Burlington, Champlain County, Vermont, Region 1. CERCLIS No. VTD980523062. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 15 Nov 1988. 7p. Available from NTIS, PC A02/MF A01.

The Pine Street Canal site is on the National Priorities List (NPL). Coal gasification by-products, wood chips saturated with residual oils and other hydrocarbons, and coal oil and tars, were deposited in an adjacent area of approximately 11 acres. The environmental contamination on-site consists of benzenes, chloroform, toluene, xylenes, naphthalene, anthracene, pyrene and other polynuclear aromatic hydrocarbons as well as lead and manganese and polychlorinated biphenyls in groundwater; dieldrin, aromatic hydrocarbons in soil and in sediment. In addition, perch taken from

the canal show low levels of phenanthrene, acenaphthene, and polychlorinated biphenyls.

23382 (PB–90-138355/XAB) **Superfund Record of Decision (EPA Region 5): E. H. Schilling Landfill, Hamilton Township, Lawrence County, Ohio (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 85p. (EPA/ROD/R–05-89/099). Available from NTIS, PC A05/MF A01.

Portions of this document are not fully legible.

The E.H. Schilling Landfill site is in Hamilton Township, Lawrence County, Ohio. The site is a 2.7-acre landfill on a larger tract of land. The predominantly rural area neighboring the site includes approximately 50 residences, which are between 0.25 mile and 1.5 miles from the site. The landfill was created by constructing a dam across a small valley. Both the landfill cover and dam have been described as inadequate, and leachate containing hazardous substances is being released through and beneath the dam. From 1969 to 1980 the landfill operators accepted both nonhazardous and hazardous wastes including styrene, phenol, acetone, alcohol, wastewater treatment sludge, coal tar compounds, and cumene. Results from a 1988 investigation reveal that soil and sediment contamination is limited to the area immediately adjacent to the dam, and ground water contamination is limited to the monitoring wells immediately surrounding the landfill and the monitoring wells downgradient of the dam. Contamination appears to be due to leachate runoff. The primary contaminants of concern affecting the soil, sediment, and ground water are VOCs including benzene; other organics including PAHs, pesticides, and phenol; and metals including arsenic. The selected remedial action for this site are included.

23383 (PB–90-143561/XAB) **Health assessment for Craig Farms (Craig Farm Drum), Parker, Armstrong County, Pennsylvania, Region 3. CERCLIS No. PAD980508527. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 14 Nov 1988. 7p. Available from NTIS, PC A02/MF A01.

The Craig Farms site was originally two abandoned strip mine pits. Between approximately 1958 and 1963, at least 2,500 tons of waste material contained in 55-gallon drums were deposited uncovered at the site. Surface water from the site flows into an unnamed tributary to the Valley Run creek which feeds into the Allegheny River 2.6 miles away. There are visible areas of dark seepage at the site. The site is used by local people for hunting. The environmental contamination on-site identified so far is resorcinol, trihydroxydiphenyls, total phenols, and benzene in groundwater. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via dermal contact with on-site environmental media. It is important to note that the site has been incompletely characterized, and environmental media and human exposure pathways other than those identified thus far may be of concern.

23384 (PB–90-143603/XAB) **Health assessment for Butler Mine Tunnel, Pittston, Pennsylvania, Region 3. CERCLIS No. PAD980508451. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 4 Jan 1989. 8p. Available from NTIS, PC A02/MF A01.

The Butler Mine Tunnel Site (BMT) is a collection and discharge point for acid mine drainage from underground coal mines. Preliminary on-site oil/groundwater sampling results have identified benzene (26 to 1,300 ppb), bis(2-ethylhexyl)phthalate (36 to 13,000 ppb), butylbenzylphthalate (5 to 600 ppb), carbon tetrachloride (ND to 14 ppb), trichloromethane (ND to 7 ppb), 1,3-dichlorobenzene (26 to 100 ppb), diethyl phthalates (ND to 2,200 ppb), dimethylphthalate (ND to 2,400 ppb), di-n-octylphthalate (110 to 792,000 ppb), ethylbenzene (ND to 4,350 ppb), methylene chloride (ND to 795 ppb), toluene (11 to 1,300 ppb), xylene (ND to 11,400 ppb), and 4-bromophenylhexylether (ND to 20,000 ppm). The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances.

23385 (PB–90-143637/XAB) **Health assessment for Brodhead Creek, Stroudsburg, Pennsylvania, Region 3. CERCLIS No. PAD980691760. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 20 Jan 1989. 7p. Available from NTIS, PC A02/MF A01.

The Brodhead Creek Site is on the National Priorities List. The 12-acre site is located in Monroe County, Pennsylvania. Coal tar waste was disposed of on-site in two large lagoons. Preliminary on-site soil, leachate, sediment, and monitoring well sampling results have identified various polynuclear aromatic hydrocarbons. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances.

23386 (PB–90-143728/XAB) **Health assessment for Dover Gas Light, Dover, Delaware, Region 3. CERCLIS No. DED980693550. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 12 May 1988. 7p. Available from NTIS, PC A02/MF A01.

The Dover Gas Light Site, located in Dover, Delaware, is the former site of a coal gasification plant (1859-1948); the site is now paved and serves as a parking lot for a music museum. The byproducts of its operations were coal oil and coal tar. Soil and groundwater contamination were discovered in feasibility test borings at the site in 1984. The contaminants of concern at the site include benzene, toluene, ethyl benzene, xylene, naphthalene, benzo-(a)-pyrene, chromium, and lead. They were identified in groundwater from a monitoring well and in soil from test pits. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contaminated groundwater, soil and air.

23387 (PB–90-143926/XAB) **Health assessment for Follansbee Site, Follansbee, Brooke County, West Virginia, Region 3. CERCLIS No. WVD004336749. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 2 Dec 1988. 7p. Available from NTIS, PC A02/MF A01.

The Follansbee site consists of process and storage facilities for the manufacture of coal tar by-products. The environmental contamination on-site consists of phenols in groundwater (up to 2,600 ppm), riverbank seeps (310 ppm), and surface water springs (3,080 ppm). The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contaminated groundwater and surface water.

23388 (PB–90-144106/XAB) **Health assessment for Lackawanna Refuse (LRS) National Priorities List (NPL) Site, Lackawanna County, Pennsylvania, Region 3. CERCLIS No. PAD980508667. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 16p. Available from NTIS, PC A03/MF A01.

The Lackawanna Refuse site is located in Lackawanna County, Pennsylvania. The site lies in an area previously used for deep mining and strip mining of coal. Municipal, commercial, industrial, and hazardous wastes were dumped in an 18-acre portion of the site containing three open strip cuts. Contaminants at the site include chromium, lead, acetone, carbon tetrachloride, chloroform, ethylbenzene, trichlorobenzene, trichloroethylene, and vinyl chloride. Until the remedial actions are complete, a potential public health threat exists from dermal absorption or ingestion of contaminated groundwater, leachate, surface water, soil, sediments, and food-chain entities, and the inhalation of volatile organic compounds and fugitive dusts.

23389 (PB–90-144148/XAB) **Health assessment for Osborne Landfill, Grove City, Mercer County, Pennsylvania, Region 3. CERCLIS No. PAD980712673. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 2 Dec 1988. 7p. Available from NTIS, PC A02/MF A01.

The Osborne Landfill site is an abandoned coal strip-mine that operated as a disposal area from the 1950s until 1978 at which time it was closed by the state of Pennsylvania. It allegedly received industrial and hazardous waste during the 1960s and 1970s. In 1983, all leaking drums and stained soil were removed from the

surface of the site. The environmental contamination on-site consists of benzene, nickel, chromium, and lead in landfill leachate; chloroethane and 1,1,1-trichloroethane in surface water; lead, pentachlorophenol, and toluene in groundwater; and benzene, toluene, tetrachloroethylene, arsenic, lead, and polychlorinated biphenyls in soil. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contaminated groundwater. Since off-site investigations apparently have not been performed to date, off-site groundwater, soil, leachate, surface water, and airborne particulates may be pathways of concern.

23390 (PB–90-144791/XAB) **Health assessment for Salford Quarry, Lower Salford Township, Pennsylvania, Region 3. CERCLIS No. PAD980693204. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 2 May 1988. 7p. Available from NTIS, PC A02/MF A01.

The Salford Quarry 3-acre site is an inactive quarry which received waste tiles, unfused tile slurry, and Number 6 fuel oil. The site was closed, graded, capped, and seeded in 1982. On-site contamination consists of inorganic borate compounds and trichloroethylene in groundwater. Samples from a spring off-site contained trichloroethylene and borate in water, and polychlorinated biphenyl (PCB) in sediment. A residential well has been shown to contain ppb borate. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via groundwater and surface water.

23391 (PB–90-148271/XAB) **Methodologies for determining the cumulative hydrologic impacts of surface mining. Task 3.** Herb, W.J. Geological Survey, Harrisburg, PA (USA). Apr 1983. 36p. Available from NTIS, PC A03/MF A01.

The report describes the cumulative hydrologic impact methodologies which are available. The need to determine cumulative hydrologic impacts (CHI) is outlined in P. L. 95-87, Surface Mining Control and Reclamation Act of 1977.

23392 (PB–90-148743/XAB) **Collection of representative coal-refuse samples for leachate generation studies. Final report.** Krapac, I.G.; Smyth, C.A.; Griffin, R.A. Illinois State Geological Survey, Champaign, IL (USA). 1984. 75p. (IL/SGS/EGN–106). Available from NTIS, PC A04/MF A01.

A statistically valid sampling plan with a known degree of precision is necessary to assess the environmental impact of coal cleaning refuse (gob) piles via leaching studies. At two gob piles located in southwestern Illinois a portable drilling rig was used to collect 200 split-spoon samples at various depths and locations. The samples were subjected to the ASTM method A water shake extraction procedure and the concentrations of 30 constituents in the shake test extracts were determined. The extract data were used to determine: the variability of constituent concentrations in the extracts; the effect of sample depth and location on constituent concentrations, the number of samples required to have the sample mean within either 5%, 10%, or 25% of the estimated population mean at a 95% confidence level, and the number of samples required to minimize sample collection and analysis costs and variances. Using the variances reported in the study and modifying the cost function to reflect an investigator's costs and precision requirements, estimates of sample numbers can be calculated for other leaching studies where gob pile material is used.

23393 (PB–90-151028/XAB) **Leakage across a bituminous coal mine barrier. Report of investigations/1989 (Final).** Moebs, N.N.; Sames, G.P. Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Research Center. 1989. 26p. (BUMINES-RI–9280). Available from NTIS, PC A03/MF A01.

Library of Congress catalog card No. 89-600200.

The U.S.Bureau of Mines is conducting research on many topics relating to the hazards of coal mining, increased production, and protection of the environment. One area of research that has received scant attention in recent years is that of water inflows, probably because few fatalities in the United States have been attributed to them. As mining goes deeper, the problem of water inflow could increase dramatically because of adjacent or overlying mines in which huge water pools are impounded. Inaccurate mine maps and ineffective barriers can constitute a serious problem for operators both from gradual inflows and sudden inrushes of water. The report describes a wide but ineffective barrier that permitted an average 240-gpm inflow to a developing mine from an adjacent mine. The anomalous geologic structure that facilitated this leakage is described, demonstrating that size, alone, is no assurance against serious leakage. Some recommendations for managing serious water inflow are included.

0110 Reserves, Geology, and Exploration

23394 (ARC-OF–1987-05) **Estimate of inferred resources of coal in the plains region of Alberta to a depth of 400 metres.** Strobl, R.S.; McCabe, P.J.; MacDonald, D.E.; Richardson, R.J.H. Alberta Research Council, Edmonton, AB (Canada). Natural Resources Div. Mar 1986. 31p. Available from Alberta Research Council, Edmonton, AB (Canada). Natural Resources Div.

This report describes the size of mineable coal resources for three geological units: the lower Horseshoe Canyon Formation, the Ardley coal zone, and the Belly River Group. A computer database was used to calculate coal resources which were then represented in graph form. Huge coal resources, that were previously poorly understood, have been delineated and will be useful in the future designation of coalfields for underground mining. 5 refs., 11 figs., 2 tabs.

23395 (ERP/CRL–89-79(OP)) **Lignite in Canada: reserves, production and utilization.** Romaniuk, A.S. Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Coal Research Labs. Sep 1989. 11p. Available from Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Coal Research Lab.

This paper examines briefly lignite reserves, production and utilization in Canada. Currently all lignite produced in Canada comes from Saskatchewan and most of it is used without upgrading for electric power generation. Upgrading technologies for Saskatchewan's lignite are currently being evaluated in an effort to expand into new markets. 7 refs., 3 tabs., 1 fig.

0120 Mining

Refer also to citation(s) 23358, 23379

23396 (ERP/CRL–87-22(TR)) **Reinforced earth.** Kolada, R.J. Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Coal Research Lab. Mar 1987. 8p. Available from Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Coal Research Lab.

This paper describes briefly the principles of reinforced earth technology with emphasis on its use in the mining industry.

23397 (ERP/CRL–88-37(OP)) **Developments in mine monitoring - a Western Canadian perspective.** Stuart, N.J.; Makosinski, A.; Kolada, R.J.; Szymanski, J.K.; Srajer, V. Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Coal Research Lab. Jun 1988. 15p. Available from Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Coal Research Lab.

This paper examines the use of mine monitoring equipment in Western Canada. A historial review of technologies used is followed by the identification of areas in which telemetry can be applied in the mining industry. Plans to develop innovative new systems, specifically improvements in hardware and in the methodology of communication are discussed.

23398 (ERP/CRL–88-66(OP,J)) **An overview of the research on rock and gas outbursts in the Sydney Coalfield, Nova Scotia.** Yuen, C.M.K.; Cain, P.; LeBel, G.R.; Stewart, D.B. Canada Centre for Mineral and Energy Technology, Sydney, NS (Canada). Cape Breton Coal Research Lab. Sep 1988. 23p. Available from Canadian Centre for Mineral and Energy Technology, Sydney, NS (Canada). Cape Breton Coal Research Lab.

Rock/gas outburst problems occuring at the Sydney Coalfield, Nova Scotia resulted in a study to: (1) identify the cause of outburst conditions, (2) to determine methods of predicting potential outburst conditions and (3) to find ways in which mining could be

conducted safely under outburst conditions. This paper summarizes the results of this research. 18 refs., 4 tabs. 7 figs.

23399 (ERP/CRL–88-71(OP,J)) **Mine planning to control hazards from spontaneous combustion.** Chakravorty, R.N. Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Coal Research Lab. Oct 1988. 31p. Available from Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Coal Research Lab.

The hazards associated with the spontaneous combustion of coal in mines are of concern both to the safety and economics of mining operations. This paper reviews current practices developed to both prevent and control this problem. Factors which should be considered in the mine planning phase are identified. 10 refs., 3 tabs., 9 figs.

23400 (ERP/CRL–88-76(TR)) **Visit to the Central Mining Research Station, Dhanbad, India.** Chakravorty, R.N. Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Coal Research Lab. Dec 1988. 14p. Available from Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Coal Research Lab.

A visit was made to the Central Mining Research Station, Dhanbad, India for a period of six weeks to review the work at CMRS mine fire laboratory, interact with the scientists and recommended measures so that R & D work related to mine fire control can be upgraded. This was carried out under the auspices of United Nation Development Programme as a TOKTEN consultant. The report briefly describes the on-going research program at CMRS with particular emphasis on mine fire, spontaneous combustion and biological control of methane.

23401 (ERP/CRL–89-51(TR)) **A procedure for the determination of the total gas content of coal.** Young, D.A. Canada Centre for Mineral and Energy Technology, Sydney, NS (Canada). Cape Breton Coal Research Lab. May 1989. 28p. Available from Canada Centre for Mineral and Energy Technology, Sydney, NS (Canada). Cape Breton Coal Research Lab.

This report was undertaken as part of a project to identify sources of gas in a coal mine, and to estimate the amount of gas released to the mine's ventilation network. The procedure used by CBCRL to determine the total gas content of coal is described. 2 refs., 7 figs., 2 tabs.

23402 (ERP/CRL–89-52(TR)) **A method to measure the coal gas release from run of the mine coal.** Young, D.A. Canada Centre for Mineral and Energy Technology, Sydney, NS (Canada). Cape Breton Coal Research Lab. May 1989. 54p. Available from Canada Centre for Mineral and Energy Technology, Sydney, NS (Canada). Cape Breton Coal Research Lab.

This report examines the release of gas to the mine's ventilation network upon transportation of the coal from the mine. A method of measurement was developed which incorporates the use of a dry test meter and lightweight sample container that can be used in the immediate mining area to measure the amount of gas from the run of the mine (ROM) coal. Results of a number of field trials are included. 2 refs., 18 figs., 10 tabs.

23403 (ERP/CRL–89-53(TR)) **Selection and testing of payload monitors for hydraulic loading equipment.** Srajer, V. Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Coal Research Lab. May 1989. 16p. Available from Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Surface Mining Lab.

Two payload monitoring systems - the WT-4000 developed by Wrey Technologies, Sydney, Australia, and the Loadrite, developed by Teledyne Canada, Thornbury, Ontario - were investigated for application at Greenhills mine in Elkford, B.C. Both systems are described and results of the WT-4000 tests installed on a Demag H-241 shovel are discussed. 3 refs., 4 figs., 1 tab.

23404 (ERP/CRL–89-54(OP,J)) **Monitoring systems for loading and hauling equipment at surface coal mines in Canada.** Srajer, V. Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Coal Research Lab. May 1989. 21p. Available from Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Surface Mining Lab.

Systems used to monitor loading and hauling equipment at surface coal mines in Western Canada were investigated. Each monitoring system examined is described and evaluated. 17 refs.

23405 (PB–90-148263/XAB) **Prediction of ground movements due to underground mining in the eastern United States coal fields. Volume 2. Surface deformation prediction system. User's manual.** Virginia Polytechnic Inst. and State Univ., Blacksburg, VA (USA). Dept. of Mining and Minerals Engineering. Dec 1987. 124p. Available from NTIS, PC A06/MF A01.

The Surface Deformation Prediction System (SDPS) is designed to provide the field engineer as well as the researcher with a detailed, in-depth analysis of ground deformations over undermined areas using three different prediction methods. For easy application, appropriate computer programs have been developed based on three different numerical formulations and a variety of ground deformation indices can be computed. Presented are the basic concepts of the SDPS, the monitoring program, subsequent analysis of the field results obtained, and the adaptation of the prediction methods for eastern U.S. mining and geological conditions. The use of the computer software developed for predicting ground deformations on the surface is discussed. The features of each program are analyzed in detail and are illustrated through a number of examples.

23406 (PB–90-151077/XAB) **Surface testing and evaluation of the multiple-unit continuous haulage system. Information Circular/1989.** Jaspal, J.S.; Erhard, L.A.; Mayercheck, W.D. Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Research Center. 1989. 70p. (BUMINES-IC–9228). Available from NTIS, PC A04/MF A01.

Library of Congress catalog card No. 89-600120.

Most of the underground coal in the United States is mined via room-and-pillar mining methods with continuous miners. The machines operate intermittently because they have to wait for shuttle cars to interchange positions. To overcome this discontinuity in shuttle car haulage and to realize the full production potential of continuous miners, the U.S. Bureau of Mines developed a multiple-unit continuous haulage (MUCH) system. The MUCH system consists of 12 rubber-tired vehicles and a bridge conveyor. The rubber-tired vehicles are connected by a unique mechanical linkage system to form a 250-ft train. The mechanical linkage permits the vehicles to track-retrack the preceding vehicle in both inby and outby directions. The cut coal cascades from one vehicle to another until it is discharged on the section conveyor belt. The MUCH system provides continuous haulage to the continuous miner.

0130 Transport, Handling, and Storage

23407 (DOE/FE–61819-H1) **Innovative/alternative transport modes for movement of US coal exports to the Asian Pacific Basin.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of Planning and Environment; Argonne National Lab., IL (USA). 1 Mar 1990. 179p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. Order Number DE90008162. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

This study examines a range of transportation options available to US coal exporters. Alternatives investigated include innovative approaches to rail and ocean transportation, coal-slurry-pipeline transportation, and coal-blending possibilities, as well as unconventional transport modes such as long overland conveyors and intermodal moves in containers. The study includes a comparison of possible delivered prices for the coals of interest, based on a variety of transportation-combination scenarios. Selected scenarios are presented. 145 refs., 31 figs., 43 tabs.

23408 (DOE/METC–88/6094, pp. 156-162) **Rheological and heat transfer characteristics of flowing CWM [coal water mixtures].** Novack, M. (General Applied Science Laboratories, Inc., Ronkonkoma, NY (USA)); Tsai, C.Y. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and*

gas stream cleanup systems contractors review meeting. Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The effective injection of coal-water mixtures is one of the major combustion-related problems associated with the use of CWM. It has long been recognized that moderate preheating of liquids to reduce their viscosity and surface tension is an effective means of reducing the mean droplet size when they are atomized. The objective of this research program is the development of a consistent data base and the derivation of engineering correlations for the prediction of pressure gradients and heat transfer coefficients in pressurized, heated flows of CWM. The range of heating conditions over which the data and correlations are to be acquired extends from simple convection heat transfer with laminar flow, through subcooled boiling, to nucleate boiling of turbulent suspensions of coal particles in water vapor. Results from studies on convective heating, subcooled boiling, and nucleation boiling are summarized. A final report is being prepared.

23409 (DOE/PETC/TR–90/3) **A method for measuring the material moduli of granular materials: Flow in an orthogonal rheometer.** Rajagopal, K.R. (Pittsburgh Univ., PA (USA). Dept. of Mechanical Engineering); Massoudi, M. USDOE Pittsburgh Energy Technology Center, PA (USA). Jan 1990. 24p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90007160. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In this report, a theoretical approach that leads to the experimental characterization of the material moduli of granular media is discussed. A general constitutive model that predicts the possibility of both of the normal stress-differences and that is properly frame invariant is derived. As a result of this generalization, there are many material properties which appear in the model and it is essential to devise experiments that will help measure these material moduli. Simple shear and Couette flows would provide some information for some of these material properties. If these simple flows are used in conjunction with the flow in an orthogonal rheometer, which has been used to characterize the material moduli of viscoelastic fluids, many of the material properties of granular materials, in principle, can be measured. Analysis for simple shear flow and flow in an orthogonal rheometer is provided and a detailed discussion as to the advantages of using an orthogonal rheometer to measure these properties is also presented.

23410 (ERP/CRL–88-68(TR)) **A synopsis of current and planned coal transportation initiatives.** Stewart, D.B.; Zahary, G. Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Coal Research Lab. Sep 1988. 14p. Available from Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Coal Research Lab.

Reducing the costs involved with transportation of Canada's mineral resources is of considerable concern to mineral producers. This report identifies the planned and existing research initiatives of thirteen Canadian companies involved in the transport of coal. The brief description of each project includes the name and address of contact persons who can provide additional information.

23411 (PB–90-147554/XAB) **Raw-coal concentration sensor for hydrotransport. Final report, 25 June 1976-20 September 1988.** Verbinski, V.V.; Cassapakis, C.G.; del Esdernier, D. Science Applications International Corp., San Diego, CA (USA). 20 Sep 1988. 265p. (SAIC–88/1638). Available from NTIS, PC A12/MF A02.

The report presents the development of a raw coal concentration sensor for hydrotransport of coal and refuse (rock) from underground mines, and the results of an international test series carried out at the Colorado School of Mines Research Institute in Golden, Colorado, the U.S. Bureau of Mines, Hydraulic Transport Research Facility in Pittsburgh, Pennsylvania, Saskatchewan Research Facility in Saskatoon, Saskatchewan, Canada, and the Steinkohlenbergbauverein Test Facility in Essen, West Germany. Test results are presented for a three-component sensor and also for the more rugged two-component (all nuclear) sensor.

0140 Combustion

Refer also to citation(s) 23263, 23287, 23288, 23296, 23297, 23314, 23333, 23335, 23337, 23347, 23357, 23359, 23373, 23408, 23710, 23718, 23838, 23915, 23984, 24137

23412 (ANL/ESD/TM–1) **Computer modeling of erosion in fluidized beds.** Lyczkowski, R.W. (Argonne National Lab., IL (USA). Energy Systems Div.); Bouillard, J.X.; Berry, G.F.; Gidaspow, D. Argonne National Lab., IL (USA). Energy Systems Div. Jan 1990. 94p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. Order Number DE90008159. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

Erosion in fluidized-bed combustors, which comprises a near-commercial method of burning coal cleanly, has surfaced as a serious issue that may have adverse economic effects. The evidence suggests that the key to understanding this erosion is detailed knowledge of the coupled and complex phenomena of solids circulation and bubble motion. The FLUFIX computer code has been developed for this purpose. Computed hydrodynamic results compare well with limited experimental data (including the bubble frequency and size and the time-averaged porosity distribution) taken in a thin two-dimensional rectangular fluidized bed containing a rectangular obstacle. Six erosion models, which form a preliminary consolidation, are critiqued; a methodology is described whereby the computed hydrodynamic results can be used with these erosion models. All previous attempts (none involving fluidized beds) to couple fluid mechanics and erosion models are reviewed. Both transient and time-averaged energy dissipation models are developed, and shown to generalize the so-called power dissipation model used successfully to analyze slurry jet pump erosion. It is demonstrated, by explicitly introducing the force of the particle on the eroding material surface, that impaction and abrasive erosion mechanisms are basically the same. Linkage is made to the single-particle erosion models. The implementation and finite-difference equations are summarized. Finally, transient, time-averaged and time-averaged transient energy dissipations for the energy dissipation and Finnie erosion models are compared. The computed erosion rates are compared with each other and with available erosion data literature to validate the calculations. The results are reasonable, but a single-obstacle erosion experiment is necessary, to validate the computations. 99 refs., 28 figs., 5 tabs.

23413 (ANL/FE–89/7) **High-temperature oxidation and sulfidation of Fe-20Cr-16Ni-4Al-1Y_2O_3 oxide-dispersion-strengthened alloy.** Malik, A.U.; Natesan, K. Argonne National Lab., IL (USA). Oct 1989. 41p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. Order Number DE90007897. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

High-temperature oxidation and sulfidation studies were conducted on an oxide-dispersion-strengthened alloy of composition Fe–20Cr–16Ni–4Al–1Y_2O_3. The oxidation studies were conducted in air and low-pO_2 environments over a temperature range of 650 to 1200°C. Results are also reported on the sulfidation resistance of preformed oxide scales and the influence of reoxidation of preformed sulfide scales. Detailed microstructural results and x-ray diffraction analysis data are presented to substantiate the corrosion behavior of the alloy over the wide range of conditions anticipated in fossil-energy systems. Data are also presented on the corrosion behavior of the alloy in oxygen/sulfur mixed gas atmospheres, and the results are used to compare the corrosion behavior of the present alloy with other chromia- and alumina-forming alloys. 21 refs., 32 figs., 6 tabs.

23414 (CONF-880770– III.3-III.22) **Site specific coal energy system assessments.** Rezaiyan, A.J. (Sheladia Associates, Inc., Rockville, MD (USA)); Bluestein, J.; Phan, L.; Tanasescu, D.; Tarpara, J.; Zwack, B. Sheladia Associates, Inc., Rockville, MD (USA). Sep 1988. From Coal - targets of opportunity workshop; Washington, DC (USA); 12-13 Jul 1988. In *Coal: Targets of opportunity workshop: Proceedings.* Order Number DE89002076. Available from NTIS, PC A12/MF A01.

The objective of this study are twofold: (1) to evaluate the performance and economics of small, coal-based energy systems for

specific commercial facilities, and (2) to identify barriers that potential system operators may face in installing and operating a coal-based system. By using actual buildings as the basis for the analysis, the evaluation can address the important issues that depend upon the specifics of building design and operation. The actual energy cost for these buildings also provides a baseline against which to compare the costs calculated for the coal-based technologies. This paper first characterizes the commercial sector and provides the rational for choosing a hospital and a high school for analysis. It then delineates the specific characteristics (size, thermal and electrical loads, location, etc.) of the hospital and high school under study. Finally, it provides a summary of the performance and economics of the energy systems studied and discusses some of the barriers to installing and operating a coal-based energy system.

23415 (CONF-880770– III.23-III.41) **Design and operation of a coal-based energy system for a diverse urban district heating network.** Nyman, H.; Schuerger, M. Sheladia Associates, Inc., Rockville, MD (USA). Sep 1988. From Coal - targets of opportunity workshop; Washington, DC (USA); 12-13 Jul 1988. In *Coal: Targets of opportunity workshop: Proceedings.* Order Number DE89002076. Available from NTIS, PC A12/MF A01.

This paper presents the experience gained by a private district heating utility in designing and operating a coal-based hot water district heating system in St. Paul, Minnesota. The primary components of the system are three traveling grate stoker coal-fired boilers (150 Ml b/hr each), three small package boilers for peaking, 75,000 feet of twin steel insulated distribution pipeline, and the customers' heat exchanger installations. Presently this system provides thermal energy for space heating, domestic hot water, and industrial process to 65 percent of downtown St. Paul. This includes over 125 residential, large and small commercial, government, and hospital buildings, plus approximately 300 townhomes. Although the hot water distribution network was installed and began operation in 1983, the power plant was constructed in 1907, and the coal-fired boilers currently in use were installed in the 1960's. These boilers, under previous ownership, had difficulty meeting U.S. EPA air quality requirements. This situation was reversed in the early 1980's through modifications to the mechanical dust collectors, a strong commitment to train and support skilled boiler operators, and an improved coal purchase specification. This coal-based energy system is shown to be an environmentally sound, reliable, and cost-effective means of serving the thermal energy requirements of a diverse urban load through hot water district heating.

23416 (CONF-880770– III.43-III.56) **The Innovatech system to replace distillate in small industrial, commercial, and residential applications.** Goodman, R.M. (Energy International, Inc., Pittsburgh, PA (USA)); Davis, B.E.; Trivett, G.S. Sheladia Associates, Inc., Rockville, MD (USA). Sep 1988. From Coal - targets of opportunity workshop; Washington, DC (USA); 12-13 Jul 1988. In *Coal: Targets of opportunity workshop: Proceedings.* Order Number DE89002076. Available from NTIS, PC A12/MF A01.

During this project, INNOVATECH will demonstrate that this small-bed, atmospheric, fluid bed combustor (AFBC) system can burn coal water fuels (CWF) at greater than 99% efficiency, automatically, environmentally clean, and with little or no user maintenance. The AFBC/CWF system is relatively easy to operate. The total combustion utilizes the synergy between the AFBC and CWF technologies. Specifically formulated CWF having high heat density (>100,000 BTU/gal) and long-term stability is stored in special storage tanks which permit fuel flow direct to the combustion chamber fuel inlet to eliminate plugging. The bubbling bed, AFBC incorporates proprietary design and control to utilize the feed characteristics of the liquid fuel and the agglomerating characteristics of the swelling coals to maintain optimum bed temperatures for complete combustion/emissions control. Particulates are captured in specifically designed scrubbers/precipitators and segregated from both inert bed material and hot combustion gasses. Heat transfer is efficiently accomplished using relatively conventional units. Ash collection is designed to be self-contained within the unit, ultimate disposal requiring exchange of closed containers by the fuel supplier. This overall system responds to virtually all the requirements identified by DOE as necessary for commercialization. Successful demonstration of the units in INNOVATECH's Nova Scotia project is crucial to the development of opportunities in the US market.

23417 (CONF-880770– III.69-III.85) **Liquid coal - the future fuel for locomotive engines.** Wolfe, R.A. (UCC Research Corporation, Bristol, VA (USA)); Im, C.J. Sheladia Associates, Inc., Rockville, MD (USA). Sep 1988. From Coal - targets of opportunity workshop; Washington, DC (USA); 12-13 Jul 1988. In *Coal: Targets of opportunity workshop: Proceedings.* Order Number DE89002076. Available from NTIS, PC A12/MF A01.

When diesel engines became the most prominent of all locomotive engines, one of the biggest coal markets for steam engines vanished. Today, the Norfolk Southern and CSX Railroads use over one billion gallons of diesel fuel per year. If diesel fuel could be replaced with a coal-based liquid fuel, millions and millions of tons of coal could be utilized in this once lost market. United Coal Company, through its research division UCC Research Corporation, has been conducting coal research for the past nine years in the development of liquid coal products and coal preparation technologies. The research work for new coal-based fuels has been ongoing for the past four years. As a result, a mild gasification facility funded by the US Department of Energy, was constructed at our research facility. Various test quantities of coal-based diesel fuel have been produced for fuel characterization. Engine tests have been successfully conducted in small and medium diesel engines, including a coal truck. Currently, the authors plan to test various locomotive type diesel engines with the fuel before years end. The authors believe coal has the capability of being converted into liquid fuels which will be economically attractive for use in locomotives, automobiles and trucks. This paper presents a concept of the technical approached, accomplishments and future plans to develop coal-based diesel fuels in the transportation sector, as well as for industrial uses. In addition, valuable marketability of char, which is the major by-product of the mild gasification process, is discussed.

23418 (CONF-880770– III.99-III.120) **Coal-water fuel retrofit evaluations.** Beal, H.R. (Combustion Engineering, Inc., Windsor, CT (USA)); Gralton, G.W.; Hargrove, M.J.; Levasseur, A.A. Sheladia Associates, Inc., Rockville, MD (USA). Sep 1988. From Coal - targets of opportunity workshop; Washington, DC (USA); 12-13 Jul 1988. In *Coal: Targets of opportunity workshop: Proceedings.* Order Number DE89002076. Available from NTIS, PC A12/MF A01.

The firing of five different coal water fuels in seven oil-designed commercial furnaces was studied under contract to the Department of Energy. The fuels represented various levels of beneficiation and ash deposition tendencies. The commercial furnaces included industrial boilers, process heaters, and utility boilers. Performance predictions were completed for each commercial unit firing several of the fuels, based on the results of pilot scale tests of ash deposition and flyash erosion. Most of the units were limited in capacity by either furnace size, convection bank erosion, or convection bank fouling. Retrofit modifications for the study units included ash collection systems, burner components, furnace bottoms, fuel handling systems, and stack gas cleaning equipment. Payback periods were determined for each unit on each fuel for a range of fuel cost savings. In many cases, coal-water fuels would be economical for retrofit of oil-designed units.

23419 (CONF-880770– III.163-III.175) **Use of coal-lime-water slurry fuels in power generation.** Nadgauda, S.S. (Renova Engineering P.C., Staten Island, NY (USA)). Sheladia Associates, Inc., Rockville, MD (USA). Sep 1988. From Coal - targets of opportunity workshop; Washington, DC (USA); 12-13 Jul 1988. In *Coal: Targets of opportunity workshop: Proceedings.* Order Number DE89002076. Available from NTIS, PC A12/MF A01.

The decline in oil prices and adoption of stringent environmental emissions criteria have reduced the interest in coal-water-slurry (CWS) fuels technology. On the other hand, recent tests indicate that hydrated lime [$Ca(OH)_2$] injection in coal-fired furnaces can remove about 50% of the sulfur dioxide (SO_2) emissions. This suggests that slurry fuels made from proper quality coal, lime, and water might represent a cost-effective and flexible approach for commercializing CWS fuels, since the need for SO_2 scrubbers would be eliminated. This paper present a brief overview on the two technologies - CWS fuels and SO_2 capture via hydrated lime injection in furnaces. The reported data is then used to

conceptualize the technical and economic merits of firing coal-lime-water-slurry fuels in oil-fired utility boilers. It is concluded that by incorporating coal cleaning in the fuel preparation step (if necessary), these fuels could compete with oil in power generation.

23420 (DOE/METC–88/6092-Vol.1, pp. 158-176) **Fluidization research program at Morgantown Energy Technology Center.** Mei, J.S.; Keech, T.W.; O'Brien, T.J. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

METC is conducting extensive fluidization research in support of various Fossil Energy Programs. Despite the widespread application of fluidized-bed reactors, the basic understanding of the fluidization phenomena is imprecise and based on a guess and try approach. The METC fluidization research program was initiated in early 1986 with the objectives of developing the ability to quantitatively describe the fluid dynamic phenomena in fluidized bed applications to fossil energy systems through combined modeling, experimental, and instrumental activities. These will increase the understanding of fluidization processes and provide a sound basis for the design and scaleup of fluidized-bed reactors for fossil energy applications. The fluidization research program is focused on the specific fluidized-bed technology needs identified in four major technology areas: coal combustion, coal gasification, oil shale retorting, and hot gas cleanup. Preliminary results of the high speed differential pressure and local capacitance measurements obtained from the flow regime characterization tests conducted in the 1-foot diameter atmospheric fluidized-bed cold unit are presented. The salient design features of the 2-foot diameter pressurized fluidized-bed warm unit are described. Progress on the novel instrumentation developments, which will provide better techniques to measure bed voidage and solids circulation, are also discussed. Extensions of comprehensive mechanistic fluidized-bed codes are described. These computer codes have now been used to simulate many fluidization phenomena. Some of these results from the simulation of particular fluidization phenomena are also presented.

23421 (DOE/METC–88/6092-Vol.1, pp. 342-350) **Vaporization of trace inorganic species from coal under combustion and gasification conditions.** Hildenbrad, D.L. (SRI International, Menlo Park, CA (USA)); Lau, K.H.; Lamoreaux, R.H.; Krishnan, G.N.; Brittain, R.D. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 1.* Order Number DE88010253. Available from NTIS, PC A18/MF A01.

The objective of this project is to establish the chemical forms and relative abundances of trace inorganic vapor species n coal during combustion and gasification. Knowledge of the chemical species involved in trace element transport will be useful in designing strategies for removal of species with negative impacts on various coal use technologies. Selected samples of Illinois No. 6 and Wyodak coals were prepared for mass spectrometric analysis by low-temperature oxygen plasma ashing (LTA), and analyses were obtained of trace element distribution in LTA samples of each coal. Vapor species above both Illinois No. 6 and Wyodak LTA samples were identified. Over 50 vapor species of over 25 elements have been identified, and their dynamic pressures measured, in the temperature range 300-170K. Two new vapor species were observed above both of the coal samples: $NaBS_2$ and KBS_2. Thermodynamic data for these species were estimated and included in the data base for calculations. An existing SRI computer code for Gibbs energy minimization calculations was to allow inclusion of solution effects. The new program, CEQSOL can be used with up to 250 species of 30 elements. A data base was compiled for major and trace element vapor and condensed phase species for calculation. Initial calculations were completed to establish the vaporization behavior of major and trace elements in Wyodak coal. The predictions of the initial atmospheric pressure calculations at 873K and 1273K are shown. These results are tentative, since further modification of the data base may be necessary.

23422 (DOE/METC–88/6094, pp. 1-6) **Coal-fueled gas turbines overview.** Barton, G. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

Alternative fuels, low emissions, and improved energy conversion efficiency are three technologies being developed by Solar Turbines, Inc. Gas turbines are their main product. Heat recovery steam generators and a Rankine cycle energy recovery system are under development now. The paper concentrates on coal-fueled gas turbine development with its associated systems for particulates removal, erosion and corrosion resistant coatings, etc. A brief account of the expected economics of the system is included.

23423 (DOE/METC–88/6094, pp. 7-10) **Heat engines: Tomorrow's clean coal technology, coal-fueled diesels overview.** Blizzard, D.T. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

This presentation gives Cooper's version from an industry perspective of the impact of federally sponsored R&D programs on their own R&D program; and also discusses how they integrate the results of these R&D programs into a commercial product. The author sets the stage by giving some background on Cooper Industries and Cooper-Bessemer Reciprocating, as well as describing the strengths needed to be successful as an engine manufacturer in the DOE-METC coal water slurry project, and how Cooper plans to integrate the CWS program into an overall manageable and successful R&D program.

23424 (DOE/METC–88/6094, pp. 11-19) **Coal fueled diesel technology development.** Hsu, B. (GE Transportation Systems, Erie, PA (USA)); Leonard, G.L.; Cook, C.S. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The program objective is to develop the technology necessary for the future commercialization of a coal-fueled diesel powered system. The goal of GE Transportation Systems is to use this technology to commercialize a coal fueled diesel locomotive. Therefore the proposed research, development, and integrated testing will be directed toward achieving that goal. The development of a coal fueled diesel engine also has other potential applications in the marine, industrial, and power generation markets. The program will have the following specific objectives: Fuel - define the fuel properties independent of coal type within specified economic constraints; Emissions - evaluate and develop emissions control technology applicable to coal fueled diesel engines; Operation - demonstrate the operation of a full size, multi-cylinder, medium speed diesel engine from starting to full load and speed; Durability - demonstrate component life expectancies of greater than 1000 hours; and Proof of Concept - demonstrate a coal fueled locomotive in freight hauling service. This program is just getting under way; no results are available as yet.

23425 (DOE/METC–88/6094, pp. 20-26) **Coal-fueled diesels proof-of-concept program - Cooper-Bessemer stationary power system.** Balles, E.N. (Arthur D. Little, Inc., Cambridge, MA (USA)); Benedek, K.; Mayville, R.; Rao, K.; Kimberley, J.; Anast, K.; Johnson, S.; Barber, S. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors

review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The basic motivation behind this project is to develop coal-burning heat engine technology for 2-50 MW modular stationary power applications in the late 1990's and beyond, when oil and gas prices may rise to unacceptable levels. The Cooper-Bessemer coal-fueled modular power system will be based on: (1) Cooper-Bessemer model LSB engine (substantially redesigned for coal), with heat recovery, 2-6 MW per engine, 400 rpm, 15.5-in bore, 22-in stroke, and Conservative loading; (2) Engine-grade coal slurry, 1.0% ash or less, 6-20 micron mean particle size, and Regionally produced, tank truck delivery; (3) Allowable cost premiums of $1.1 million per engine for coal-tolerant components, plus $0.50-$1.80 per million BTU for emissions control; (4) Shorter overhaul and parts replacement intervals. The project is just in its earlier stage; no results are available as yet.

23426 (DOE/METC–88/6094, pp. 27-39) **Allison's coal fueled gas turbine proof of concept program.** Wilkes, C. (General Motors Corporation, Indianapolis, IN (USA)); Ali, S.A.; Wenglarz, R.A.; Vaught, J.M.; Vittal, B. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

Allison Gas Turbine is conducting a program to develop components for a coal-fueled gas turbine and to demonstrate operating feasibility of the overall system in a proof of concept (POC) engine test. Potential commercial applications are also being reviewed and subjected to economic analyses to ensure that the program is directed toward development of candidate products for the commercial marketplace. Allison's coal-fueled proof of concept gas turbine system utilizes a coal water slurry (CWS) fueled RQL combustor system in conjunction with an Allison 501-KB5 industrial engine. The combustion system includes, the fuel supply and injection systems, a rich zone followed by a water quench zone, and a lean/dilution zone. Ash/particulate management is accomplished with an inertial particle separator between the water quench and lean zone. The major elements of the POC program integrates the following technology and component efforts: fuel specification and procurement; combustion system design and development; particulate separator design and development; deposition, erosion, and corrosion; recuperator development; engine system control development; and engine system integration and test. Plans and procedures for all of these tasks are described. Results from the first four are discussed.

23427 (DOE/METC–88/6094, pp. 40-48) **Advanced gas turbine proof-of-concept program.** Horner, M.W. (General Electric Company, Cincinnati, OH (USA)). USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The overall objective of the present program is to develop the technological basis necessary for subsequent commercial development of a direct coal fired gas turbine power system. The direct use of coal as a gas turbine fuel offers the opportunity to burn coal in an environmentally sound manner at a competitive cost of electricity. Specific objectives of the present program are to address the technical challenges associated with combustion of coal fuels and bring lessons learned together into an integrated systems test featuring the GE LM500 aero derivative gas generator. The GE LM500 gas turbine was selected for this program because of its high efficiency and its size which is appropriate for transportation and cogeneration markets. Key technical elements of the program include combustor development, assessment of impurity effects on hot gas path components, emissions control systems development, engine modifications for coal fuel combustion and finally, a fully integrated system test. In the first eighteen program months, a prime and an alternate combustor concept were investigated: prime system - An aircraft style annular combustor modified for burning CWM fuel and Alternate - An off-board combustor integrated with a granular bed filter. Results to date on both systems are discussed.

23428 (DOE/METC–88/6094, pp. 49-58) **Westinghouse's advanced coal-fueled gas turbine program - an overview.** Diehl, R.C. (Westinghouse Electric Corporation, Orlando, FL (USA)); Kearns, D.L.; Pillsbury, P.W.; Stickler, D.B.; Goodbar, W.L.; Anast, K.R. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The objective of this contract is to establish the technology required for subsequent commercial development and application by the private sector of utility-size direct coal-fueled gas turbines. Emissions from these units are to meet or be lower than EPA's New Source Performance Standards (NSPS) for coal-fired steam generators. Successful development of a slagging combustor is the key to meeting the objectives of this contract. Critical slagging combustor technology concerns that are being addressed within this program include: slag removal; sorbent stimulated sulfur removal in the slag; suppression of NO_x formation; complete carbon burnout; adequate particulate capture; and acceptable pressure loss and availability. First, the development and testing of a subscale utility combustor, capable of supplying thermal energy for a 500-kW combustion turbine, is to be conducted during a 15-month period to study the performance of the combustor over a wide range of parameters and hardware modifications. The second task involves testing the final combustor configuration with a stationary cascade to study the effect of deposition, erosion and corrosion on air-cooled turbine vanes. Based upon the data generated within this program, the final task is to design, fabricate and test a full-size utility combustor in the laboratory. The combustor will be capable of operating at nominal conditions projected for a utility-size combustor (i.e., air flow of 40 lb/s delivered to the combustor at a pressure of 14 atm and a temperature of 700 F). Results to date are discussed on system definition, test fuel specification, and subscale combustion system.

23429 (DOE/METC–88/6094, pp. 59-68) **Coal-fueled gas turbine proof-of-concept program.** Smith, K.O. (Solar Turbines Incorporated, San Diego, CA (USA)); LeCren, R.T. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The overall program objective is to prove the technical, economic, and environmental feasibility of a coal-fueled gas turbine system for cogeneration applications through tests on a Solar Centaur Type H engine (3.8 MWe). Individual program phase objectives are: system description; component development; and prototype system verification. Three critical technology elements are included in this approach, namely: two-stage slagging combustor (TSSC) - the TSSC can combustor has demonstrated the capability at reduced scale for low NO_x emissions, high carbon conversion efficiencies, excellent turndown ratios, and high slag rejection levels; particulate rejection impact separation (PRIS) - the feasibility of this compact particulate cleanup device operated in a high-temperature slagging mode has been verified under a previous DOE-sponsored program; and coal fuel - the feasibility of using both dry pulverized coal and coal water mixture (CWM) fuels in a gas turbine has been demonstrated during Solar's combustion technology programs. Results are discussed on the following: combustor development (analytical modeling, flow visualization, combustor testing); cleanup system development (sorbent injection,

PRIS development, secondary cleanup development); coal fuel specification; and hot end simulation rig.

23430 (DOE/METC–88/6094, pp. 69-78) **Secondary atomization of CWF [coal water fuel] for gas turbine applications.** Beer, J.M. (Massachusetts Institute of Technology, Cambridge (USA)); Yu, T.U. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The main research objective is to determine the effectiveness of coal water fuel (CWF) treatment on atomization quality when applied to an ultrafine coal water fuel (solids loading reduced to 50%) and to gas turbine operating conditions (atomization at elevated pressures). Three fuel treatment techniques are used: (1) heating of CWF under pressure to produce steam as the pressure drops during passage of the CWF through the atomizer nozzle; (2) absorption of CO_2 gas in the CWF to produce a similar effect; and (3) the two combined. These techniques are expected to produce secondary atomization i.e., disruptive shattering of CWF droplets subsequent to their leaving the atomizing nozzle, and lead to better burnout and finer fly ash size distribution. Results are discussed on an angle change of CWF spray during thermal atomization; and spray tests at atmospheric and elevated pressures.

23431 (DOE/METC–88/6094, pp. 79-88) **Physical mechanisms and predictive equations for coal-water slurry atomization.** Sojka, P.E. (Purdue Univ., West Lafayette, IN (USA)). USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

This contract has four objectives: (1) to develop relationships for predicting Sauter mean diameter (SMD) when spraying Coal-water slurry (CWS) fuels, (2) to determine the physical mechanisms responsible for the atomization of CWS fuels, (3) to quantitatively and qualitatively assess the effects of CWS rheology, nozzle geometry, and combustor operating conditions on CWS atomization, and (4) to suggest new types of fuel injection nozzles capable of producing finer CWS sprays. It has been shown that a decrease in air-assist air gap width at constant air-to-fuel mass flow ratio (AFR) and relative velocity, and at mid-range values of consistency index results in a reduction in spray SMD. It has also been shown that as the fuel consistency index increases, the dependence of SMD on relative velocity is reduced. The simple correlation presented above demonstrates that the effects of relative velocity and AFR are well understood, while the effects of nozzle geometry and fuel rheology are not. Further research is required to determine exactly how parameters such as air gap width and consistency index affect the atomization process.

23432 (DOE/METC–88/6094, pp. 89-106) **Fluidic fuel feed system.** Holmes, A.B. (Technologies, Inc., Rockville, MD (USA)); Badgely, P.; Kumar, S. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The overall objective of this work is to explore and to demonstrate innovative methods for controlling, injecting, and atomizing coal slurry fuels in coal fueled diesel engines. During the past year, the program has concentrated on basic fuel injector component design configurations, development of test procedures and equipment for evaluating these components using coal slurries, and demonstration of component operation using slurry fuel mixtures. Specific accomplishments over the last year include: design and construction of a flow test apparatus with the capability to deliver coal slurry fuel and nitrogen gas at pressures to 5000 psi; fabrication and demonstration of three vortex nozzle configurations using two coal water slurries; fabrication and demonstration of one vortex valve configuration with nitrogen control; preliminary analysis of nozzle atomization jet flow patterns using photographic data; preliminary analysis of vortex valve shut off capabilities using video techniques; and completion of the preliminary design and assembly of components for a solenoid actuated vortex slurry fuel injector valve. These accomplishments are discussed.

23433 (DOE/METC–88/6094, pp. 117-122) **High temperature interaction of SO_2 with oxide sorbents.** Seehra, M.S. (West Virginia Univ., Morgantown (USA)); Gopalakrishnan, R. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The overall goal of this project is to provide fundamental information on the mechanism of sulfur capture in the interaction of SO_2 and O_2 with calcined $CaCO_3$ and $MgCO_3$ near 700 C. The novel feature of this project is the use of in-situ FTIR and ESR spectroscopies for the determination of not only the kinetics but also the nature of the products of the interaction at different temperatures and stages of the reaction. The study included the following major components: 1. Initial experiments on the characterization of MgO and dolomite using ESR spectroscopy. 2. In-house construction of a versatile high vacuum system which can handle corrosive gases such as SO_2 and H_2S. 3. Acquisition of a FTIR spectrometer, and a high vacuum, high pressure IR cell for in-situ measurements. 4. Experiments on the characterization of chemical species formed during the high temperature interaction of SO_2 with MgO and CaO. 5. Kinetics of the high temperature interaction of SO_2 and O_2 on CaO, MgO, CaO + MgO mixture and calcined dolomite. Tasks 1 through 4 and a part of task 5 have been completed. Results are presented.

23434 (DOE/METC–88/6094, pp. 123-131) **Combustion/deposition of coal-derived fuels.** Anderson, R.J.; Richards, G.A.; Logan, R.G.; Meyer, C.T. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

An in-house project is addressing the basic mechanisms responsible for the formation of deposits of ash residue on surfaces with the objective of developing techniques to control the adverse effects of deposits on gas turbine performance when using coal and coal-derived fuels. The project consists of both experimental and theoretical tasks. The combustor and leading edge of a stator vane of a combustion gas turbine are simulated using METC's Deposition Combustion Entrained Reactor (CDER). This laboratory-scale facility allows a variety of important parameters including combustor temperature, target surface temperature, residence time, fuel-to-air ratio, pressure, and contaminants/additives to be independently controlled for specific tests. Results from deposition tests in the CDER have provided quantitative data on the deposition potential for a number of common coals as well as pretreated and beneficiated coals. Recent results have confirmed the importance of surface temperatures on deposit formation with a calcium additive exhibiting completely opposite effects on deposit formation depending on the surface temperature. A deposition model (based on the premise that high temperature liquids present in the ash residue enhance deposition) has been able to qualitatively predict the experimental deposition results. In many instances, the model has demonstrated remarkable quantitative agreement with the experimental data. This complement of experimental and theoretical activities is expected to provide a clear insight into the fundamental mechanisms responsible for deposit formation and allow rational trade-offs between system design, operation and economics for the use of coal and coal-derived fuels in combustion gas turbines.

23435 (DOE/METC–88/6094, pp. 132-139) **Contaminant release and removal - NOx studies.** Casleton, K.H. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The objective of these studies is to investigate the chemical kinetics associated with NOx formation and control mechanisms to support the development of NOx control strategies for advanced heat engine systems. Of particular interest are means to optimize staged combustion (air injection), reburning (fuel injection), and sorbent (e.g. ammonia or cyanuric acid) injection. The initial literature search and data evaluation activities have identified large gaps in the knowledge of the rates of important fundamental processes at conditions relevant to NOx formation and control processes. Experimental studies recently initiated will serve to narrow these gaps. These experimental studies are performed using a high-temperature photochemistry technique wherein a radical species of interest is generated via the photolysis of an appropriate precursor molecule. The reaction of these radicals with a reactant gas is monitored by following the decay of the radical population via laser induced fluorescence. Using this method, absolute rate coefficients for the reaction of CN radicals with H_2 have been measured as a function of temperature over the range 368 - 1333 K. CN radicals were generated by 193 nm excimer laser photolysis of dilute C_2N_2/Ar mixtures and monitored by laser induced fluorescence near 386.7 nm under pseudo-first order conditions. The overall rate coefficients for CN consumption by H_2 can be fit to an Arrhenius expression of the form $k(T) = 6.6 \times 10^{-11} \exp(-2600K/T)$ cm^3 $molecule^{-1}$ s^{-1} with statistical uncertainties of $\pm$ 28% at 368 K and $\pm$ 15% at 1333 K. In addition, limited studies of similar reactions of CN with methane and ethane have been performed.

23436 (DOE/METC–88/6094, pp. 140-149) **Modeling diesel performance with alternate fuels.** Stone, K.R. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The objective of the diesel engine simulation activities at the Morgantown Energy Technology Center (METC) is to provide engine performance estimates for use in assessing the thermal performance, environmental intrusion, and economic incentives of diesel systems fired with coal-derived fuels. Because diesels are part of a total system, the diesel engine modeling work is frequently integrated with modeling of other system units (gasification, sulfur removal, heat recovery, etc.). The results of two scoping studies are presented. The first study analyzes engine performance when fired with mixtures of coal powder and natural gas. The second study examines coal-derived, low-Btu gas as a diesel fuel. For both studies, the primary modeling tool was a diesel cycle simulation developed at the Texas A&M University for METC. In the first study the coal and natural gas were fumigated into the engine along with the air. Cases involving 10, 50, and 90 % coal were modeled using different equivalence ratios, engine loadings, and particle sizes to quantify the effect of these parameters on efficiency and on peak cylinder pressure and temperature. A uniform coal particle size of 15 microns was found to most suitable on the basis of peak cylinder pressure for a 90% coal mixture at full load. This size limits the peak cylinder pressure to 2000 psia. For the second study, two gasifier-diesel systems were selected for simulation and analysis. One of these systems supplied cold fuel gas at 100 F to the diesel; the other system supplied hot fuel gas at 500 F. The thermal efficiency was estimated to be 26.3% (12,990 Btu/kWh heat rate) for the cold gas system, and 24.0% (14,220 Btu/kWh) for the hot gas system.

23437 (DOE/METC–88/6094, pp. 150-155) **Fouling and corrosion correlations for coal-fired gas turbines.** Ahluwalia, R.K. (Argonne National Laboratory, IL (USA)); Im, K.H. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The objective of this task is to develop mathematical models which describe the formation and transport of vapor and ash in coal-fired gas turbines. These will identify the important surface deposition phenomena on turbine blades as well as characterize the effects of coal pretreatment and operating conditions on turbine performance. The previous work pertaining to ash adhesion on contacting surfaces was revisited with particular emphasis on glue limited deposition. Depending on the kinetics of gas phase reactions, the glue agent can be liquid sodium sulfate or sodium silicate. The important aspects of the updated adhesion correlation model are: sodium sulfate mass transfer/sodium silicate formation; particle contact energetics; sintering of deposit; deposit spallation; and heat transfer through deposit. The foregoing adhesion model was used to conduct a parametric study of sticking coefficient for ash contact on the pressure surface of a turbine blade. The results are regarded as qualitative in that fixed functional forms were used for temperature dependent deposit strength and thermal conductivity. Results to date are discussed.

23438 (DOE/METC–88/6094, pp. 163-172) **Combustion research for advanced heat engine power systems.** Baxter, L. (Sandia National Laboratories, Livermore, CA (USA)). USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The objective of this research is to provide baseline data on the critical combustion parameters which influence the development of combustors for stationary power heat engines such as gas turbines and diesels. The specific objectives for this year are to determine the role of coal-water slurry (CWS) additives on the formation of coal particle aggregates during slurry droplet vaporization and combustion and to evaluate the impact of these aggregates on the combustion behavior of slurry-fired heat engines. Typical CWS's are fired with approximately 50 % solids, 49 % water, and 1 % total additives. The additives are primarily composed of dispersants and stabilizers. These are included both to improve the rheological properties of the slurry and to slow the rate of settling of coal in the slurry. This project involves both bench-scale, experimental studies and computational modeling. Each of these project elements is described along with results available thus far.

23439 (DOE/METC–88/6094, pp. 173-178) **Performance and emissions of coal-fueled engines using group combustion theory.** Caton, J.A. (Texas A and M Univ., College Station (USA)); Annamalai, K. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The objectives of this study are: to formulate a non-steady group evaporation and combustion model; to formulate the detailed engine heat transfer and pollutant formation models; to integrate the group combustion, heat transfer, and pollutant formation models into the coal-fueled engine cycle simulations; to verify the cycle simulation results by comparing to experimental data from the literature; and to use the completed cycle simulation to (i) investigate the details of ignition and combustion in diesel engines, (ii) to examine overall engine performance and emissions. A group combustion theory applicable to diesel engine environment has been developed. The inclusion of group effects result in increased ignition delay and combustion duration times and decreased indicated

thermal efficiency. The decrease in heat rejection with insulting materials results in increase of indicated thermal efficiency but not significantly since exhaust losses are also increased. Thermal NO_x is less in coal-water fired diesel engines compared to diesel fired engines. The engine cycle simulation model now includes group effect and heat loss and pollutants emission models.

23440 (DOE/METC–88/6094, pp. 179-189) **Developing a scientific and engineering data base for the use of low-rank coals [LRCs] in diesel engines.** Swanson, M.L. (Univ. of North Dakota, Grand Forks (USA)); Mann, M.D.; Collings, M.E.; Hauserman, W.B. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The overall objective of this program is to develop a scientific and engineering data base on the utilization of subbituminous and lignitic coals for emerging heat engine technologies, specifically diesel applications. Research will be directed toward understanding the characteristics of LRC fuels produced from existing and advanced beneficiation processes for diesel engine applications. Combustion studies will provide functional relationships between fuel properties and the subsequent products of combustion, including release and deposition of alkali metals and other ash constituents. The formation of nitrogen and sulfur oxides and other potential environmentally detrimental species, along with methods to reduce their emission levels, will be investigated. The impact of LRC fuels on diesel engine components, including injection systems and combustion chambers, will also be studied. During this year, effort was concentrated on construction and shakedown testing of the single-stroke diesel simulator and shakedown and combustion testing of low-rank coal slurry fuels in the constant volume combustion bomb. As times was available, modifications to the 30-hp diesel engine were made to prepare it for firing coal-derived liquid fuels. The results from these activities are reported here.

23441 (DOE/METC–88/6094, pp. 190-199) **Develop fundamental data base resultant from turbine simulator tests of low-rank coals.** Swanson, M.L. (Univ. of North Dakota, Grand Forks (USA)); Mann, M.D.; Jones, M.L.; Collings, M.E.; Hauserman, W.B. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The overall objective of the Turbine Combustion Phenomena Program is to expand the scientific and engineering data base for the fundamental low-rank coal (LRC) reactions to support advanced pressurized combustion systems such as those found in heat engine applications. Fundamental research on the use of low-rank coal slurries for gas turbine engine applications will develop data that will: (1) quantify the potential advantages of low-rank coal's higher reactivity and non-agglomerating tendencies; (2) help in determining fuel specifications; and (3) indicate needed design modifications in the gas turbine engines themselves. Research will be directed toward understanding the effects of low-rank coal and slurry properties (including ash level and composition, moisture levels, and slurry rheology) on the combustion efficiency, vaporization and deposition of inorganics, and erosion of materials in pressurized combustion systems. The intent of this research is to establish the relationships between LRC properties and gas turbine engine operational parameters and the comparison of these relationships with those established for diesel fuel and bituminous coal slurries. The objectives of this program will be accomplished using a constant volume combustion bomb and a 1 MM Btu/hr two-stage gas turbine simulator capable of firing coal-water slurries. Shakedown testing of the turbine simulator using No. 2 diesel fuel and combustion tests using a Beulah-Zap lignite slurry were performed. Particulate and gas samples collected during tests were used to calculate combustion efficiencies. Results are described.

23442 (DOE/METC–88/6094, pp. 228-237) **Development of an advanced coal-fired gas turbine combustor.** Diehl, R.C.; Stickler, D.B.; Loftus, P.J.; Kozak, A.A.; Hals, F.A.; Pillsbury, P.W. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The objective is to develop the technology base for an advanced direct coal-fired gas turbine system for electric utility application. The approach under investigation is based on a multistage, slagging combustor, which incorporates NO_x, SO_x, and particulate emissions control. Instead of requiring a low-ash, highly beneficiated coal, the slagging combustor concept allows the use of raw or moderately cleaned, utility grade coal of higher ash content, thus maintaining a lower fuel cost. The feasibility of such a direct coal-fired combustion system hinges on the success of the slagging combustor itself, and it is with this element of the system that this paper deals. The combustor design incorporates a fuel-rich primary stage, a second gas cleaning stage and a third stage for final oxidation and dilution. NO_x emissions are controlled by staged combustion. SO_x emissions are controlled by sorbent injection, followed by separation of reacted sorbent with the ash material in the second stage. Particulate emissions are controlled by a high efficiency slagging impact separator and an optional slagging cyclone. The preliminary design for all major combustor components was based upon extensive modeling of the physical and chemical processes involved, using a 3-D, steady state, two phase, turbulent, reactive flow code developed at ARL. Fabrication of the subscale slagging combustor and modification of the ARL Haverhill test facility is nearing completion. Shakedown testing of the combustor is expected to begin shortly.

23443 (DOE/METC–88/6094, pp. 238-246) **Coal-fueled gas turbine combustion system technical progress report.** LeCren, R.T. (Solar Turbines Incorporated, San Diego, CA (USA)); Cowell, L.H. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The objective of this portion of the contract is to design and test a full-size combustor to be used in a Type H Centaur Engine for the proof-of-concept test. The combustion system must burn a range of coal fuels efficiently, stably over the engine operating range with acceptable emissions. In addition since this is a slagging combustor the goal is to remove at least 60% and preferably more than 70% of the ash in the fuel slag in the primary zone. The past year has been concentrated on testing of the Two Stage Slagging Combustor (TSSC). It features a rich primary zone to suppress the conversion of fuel-bound nitrogen to NOx and a lean secondary zone. Its operation is described. The status of the performance of this combustor was that it had acceptable emissions and operating range and stability; the slag retention in the primary was 70% which was considered acceptable but a higher value was desired; there was some slag flowing out of the primary zone forming a chimney in the secondary zone; and some raw fuel could escape from the primary zone. To correct these shortcomings a number of alternate designs were considered. Two, designated Mod. 1 and Mod. 2 were fabricated and tested. To evaluate the alternate designs several tools were used. A flow visualization rig was built which uses neutral density helium filled soap bubble as tracers. A computer program called INTERN which was developed by Northern Research was utilized. The ultimate tool is the combustor rig where the designs are tested at the same inlet conditions as encountered on the engine. The results of these studies are discussed.

23444 (DOE/METC–88/6094, pp. 247-257) **Coal-fired gas turbine combustion systems.** Sabla, P.E. (GE Aircraft Engines, Cincinnati, OH (USA)); Ekstedt, E.E. USDOE Morgantown Energy

Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The overall objective of the Advanced Coal-Fueled Gas Turbine Systems Program is to develop the technological basis necessary for subsequent commercial development of a direct fired coal-fueled gas turbine power system. The system concept for this program uses an LM500 advanced aero-derivative gas turbine engine designed for direct firing of coal fuel. The specific objections of this project are to design and develop an on-board annular combustion system compatible with the LM500 gas turbine and evolve a conceptual design of an off-board combustion system without exhaust cleanup. The annular system must be capable of operating on a coal water mixture (CWM) without pilot fuel assistance at base load operation as well as satisfactory operation on conventional fuels. One of the key objectives of this program is to demonstrate low emissions, ash control, and durability in a metal lined on-board combustion system. The off-board system must be compatible with the existing gas turbine and provide for continuous operation of the system. The combustor program involves two systems: an aircraft style annular combustor modified for burning CWM fuel and an off-board combustor integrated with a granular bed filter. Results to date are described.

23445 (DOE/METC–88/6094, pp. 258-271) **Coal fired gas turbine combustion system: Allison gas turbine technical progress report.** Wilkes, C. (General Motors Corporation, Indianapolis, IN (USA)); Razdan, M.K.; Santanam, C.B. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The primary purpose of this project is to develop and demonstrate an advanced coal fueled gas turbine in the 3000+ hp class. The principal objective of this program is the development of a combustion system that is capable of burning a prepared coal fuel at maximum efficiency with minimum ash carry over to the turbine. Control of sulfur and NOx emissions is also a program objection. The combustor program is divided into two major phases. The initial development effort utilizes a 1/8th scale modular combustion system designed to investigate major combustion parameters, and a full scale system that will undergo further rig development before being integrated with a modified industrial gas turbine. The program will culminate with a demonstration proof-of-concept engine run on coal-water slurry (CWS) for 50 hours. This report describes the progress made during the bench scale testing and full scale hardware design phase. Results which are discussed are: combustion system flow splits, coal water slurry fuel property improvements and atomization testing, bench scale combustion test, coal conversion efficiency measurements, coal combustion model, lean zone flammability, and sulfur sorbent testing.

23446 (DOE/METC–88/6094, pp. 272-282) **Determination of the fate of alkali species in advanced coal conversion systems.** Krishnan, G.N. (SRI International, Menlo Park, CA (USA)); Wood, B.J.; Brittain, R.D.; Lamoreaux, R.H.; Platz, R.M.; Smith, G.P. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The general objective of this program is to understand the chemical and physical phenomena that lead to the formation of corrosive alkali species in coal combustion and gasification processes. The research effort is directed specifically toward identification and quantification of sodium species and their interaction with other gases and particles present in a pressurized-fluidized bed reactor (PFBR). The paper describes the test plan, design of the bench-scale PFBR, design of the high-pressure sampling mass spectrometer system, laser-based diagnostic techniques to be used to measure the concentration of sodium species, particle sampling, and modeling.

23447 (DOE/METC–88/6094, pp. 305-315) **Coal-water fuel combustion enhancement by means of high intensity sound.** Reethof, G. (Pennsylvania State Univ., University Park (USA)); Scaroni, A.; Yavuzkurt, S. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The objectives of this contract are to theoretically and experimentally determine the feasibility of enhancing the combustion of coal-water fuels by means of high intensity sound at the proper frequency. The principal applications considered in this research are various types of heat engines such as gas turbines and piston engines. Coal-water fuels are injected into their combustors as finely dispersed mists by atomizing spray nozzles. The attractiveness of these highly loaded coal-water mixtures include their pumpability, easy storability and non-flammability compared to oil, natural gas and finely pulverized coals. In the research the authors expect to show that high intensity sound will substantially increase the convective heat transfer and mass transfer rates during the droplet evaporation phase, coal particle heating to ignition, and oxygen diffusion to the burning char particles. Thus the burning process is expected to take place in a shorter time and at greater intensities resulting in shorter and more efficient combustors. Three tasks and preliminary results from these are described: (1) development and testing of theoretical approach; (2) design, development, and testing of sonic water spray evaporator and other bench scale experiments; and (3) design and development of a new sonically-enhanced small coal-water fuel research combustor.

23448 (DOE/METC–88/6094, pp. 350-360) **Coal-fueled diesels: Systems research.** Koch, R.L. (General Motors Corporation, Indianapolis, IN (USA)); Horton, C.E.; Uzkan, T.; Ryan, T.W. III; Kamo, R. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The objectives of this project are to: perform a Life Cycle Cost Economic Study for six specific types of coal-fueled locomotives; experimentally investigate the friction and wear characteristics of advanced technology wear-resistant materials and determine which should be used in subsequent coal-fueled diesel wear tests; establish reliable operation of a two-cylinder type 645 (two stroke) General Motors diesel engine running on coal water slurry (CWS) fuel for a period of ten (10) hours (with an EMD internal goal of < 10 percent DF-2 pilot fuel); determine the relative and specific wear characteristics for specially coated piston rings and liners subjected to running in a 645 type diesel engine for 1000 hours of DF-2 fuel and 10 hours of operation with CWS as the main fuel; characterize the products of combustion in the exhaust stream for CWS fueled two-cycle General Motors diesel engines; and complete an assessment investigation and issue a Topical Report for coal-fueled diesel engine exhaust emissions. The main focus of this presentation is to report the integration of results from this project's activities into an investigation strategy for meaningful engine component wear tests. To accomplish this, the authors will be operating our test engine with as much coal water slurry fuel as they can possibly burn with minimal DF-2 pilot charge aiding the CWS combustion. This project is described, then preliminary results are summarized for the emissions assessment program and the tribological investigation for materials potentially suitable for coal-fueled diesel combustion components.

23449 (DOE/METC–88/6094, pp. 361-370) **Coal-fuel diesel combustion: General Electric test results.** Hsu, B.D. (General

Electric Corp., Schenectady, NY (USA)). USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

In this last phase of full scale single cylinder engine test, the GeCRD developed accumulator based fuel injection equipment (System III FIE) is being tested on engine with coal-water slurry fuel. The objectives are to investigate the engine combustion resulted from such FIE and to find out about the design improvements and controls needed for satisfactory engine operation. The following conclusions have been made. With high injection starting pressure of the System III accumulator FIE, the CWS fuel ignition delay time is much shorter than the positive displacement type System II FIE. The accumulator FIE can provide complete CWS fuel burnout under part engine load condition. Used with low flow nozzle, the accumulator injector can provide the kind of engine heat release pattern that develops low cylinder firing pressure and high combustion efficiency. In order to place hardened insert into the injector tip, straight hole configuration is better than external cone shape hole. The deficiency of the longer injector hole length to diameter ratio can be somewhat compensated by using higher injection pressure. Higher charge pressure is needed for the present System III accumulator FIE to obtain full engine power. The present System III FIE cannot effectively govern the engine speed when saturation charge pressure is reached. Better governing system has to be developed.

23450 (DOE/METC–88/6094, pp. 371-382) **Coal fueled diesel systems research, coal fueled diesel combustion: Cooper-Bessemer test results.** Balles, E. (Arthur D. Little, Inc., Cambridge, MA (USA)); Benedek, K.; Mayville, R.; Rao, K.; Kimberley, J. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The goal of the overall program is to contribute to the knowledge base for the development of coal-fueled diesel engines for stationary power applications. The purpose of Task 2 is to conduct experimental research and development which will enable Cooper-Bessemer to design a coal-fueled engine which ultimately can meet commercial performance criteria. Objectives of Cooper-Bessemer engine tests are as follows: develop a high pressure fuel injection system with sufficient reliability and spray characteristics to allow steady-state short engine runs; study the ignition requirements and combustion characteristics of CWS under engine conditions; evaluate different CWS fuel specification; evaluate the initial wear rates of in-cylinder components; and determine the emissions level of a diesel engine operating on CWS. Apparatus, instrumentation, and fuel are described. Results and accomplishments are discussed under the following headings: injection system development; ignition and combustion; effect of CWS fuel formulation; component wear; and emissions.

23451 (DOE/METC–88/6094, pp. 383-395) **Diesel engines, liquid fossil fuels, a scoping study.** Ayers, W.J. Jr.; Strickland, L.D.; Wojewodka, R.A.; Leep, J.R. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The objective is to determine the feasibility of using liquids from fossil fuel conversion processes as fuel for a compression ignition engine for applications in stationary and heavy transportation heat engine applications. This paper provides results from a scoping study in which a combustion bomb and a research diesel engine were used to determine the ignition, combustion, emission and performance characteristics of several different liquid fossil fuels. One objective of the study was to obtain a quick assessment of the compatibility of the fuels to compression ignition applications. A second objective was to obtain operating experience with the fuels to develop a more refined experimental design for addressing the technical barriers of using the fuels in engine applications. The fuels used in the study were derived from several gasification processes, a liquefaction process and an oil shale retort. All of the fuels were untreated, direct from the conversion process, with the exception of the liquefaction fuels which had been further refined. The engine speeds used in the test matrix were between 15-25 revolutions per second with intake air at typical turbo boost conditions in reference to temperature and pressure. The ignition gas temperatures and pressures used in the combustion bomb ranged from 650 to 925 degrees Kelvin and 4100 to 7100 kilopascals respectively. The fuels were combusted in an as received state without additives (i.e. a diesel pilot). The base line fuel for the study was a research grade, number 2, diesel fuel. In general the fuels provide excellent combustion characteristics at high ignition gas temperatures and pressures. At lower ignition gas temperatures and pressures the fuel had poor combustion characteristics.

23452 (DOE/METC–88/6094, pp. 396-408) **Extending and enhancing the scientific base for advanced coal-fueled power systems utilizing heat engines.** Kamo, R. (Adiabatics, Incorporated, Columbus, IN (USA)); Kakwani, R. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The objectives of this program are to improve the combustion efficiency of coal fuel in a diesel engine, thereby increasing the coal-fueled engine's thermal efficiency. The thermal ignition combustion system (TICS) concept for micronized coal combustion will be further studied to enhance the combustion of coal powder fuel, fumigated with the intake air, in an adiabatic diesel engine. The accomplishments to date include the following: (1) Design, fabrication and engine testing of improved coal feed system for fumigation of coal powder to intake air. This system has no moving parts and results in consistent fuel delivery for the coal-fueled engine operation. (2) Design, fabrication and engine testing of precombustion chamber made from a superalloy material (Hastelloy X). Also, a precombustion chamber made from silicon nitride ceramic has been designed and fabricated. (3) Design, fabrication and engine testing of wear-resistant ceramic-coated piston rings and cylinder liner. (4) Lubrication system was improved to separate coal particles from the contaminated lubricating oil. (5) Control the ignition timing of fumigated coal powder fuel by the exhaust gas recirculation (EGR), controlling precombustion chamber temperature, and lower compression ratio. EGR was found to retard the ignition timing which results in optimized engine cycle and lower NO_x emissions, peak cylinder pressure and rate of pressure rise. (6) Coal-fueled engine testing was conducted in the dual-fuel (with diesel pilot) and 100% coal-fueled engine configurations. These engine tests show fast burning, higher cylinder pressures and high heat release rates for the combustion of coal powder fuel. Coal-fueled engine test results are presented.

23453 (MRP/MSL–88-41(OP&J)) **Sulphur capture during the combustion of Minto coal in a 100-mm dia. CFB combustor.** Liang, D.T.; Hamer, C.A. Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Mineral Sciences Labs. 1 Jun 1988. 5p. Available from Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Mineral Sciences Labs., Extractive Metallurgy Lab.

The purpose of this study was to examine the performance of several limestones during coal combustion in order to provide sulphur capture efficiencies as sorbent selection criteria. Minto coal was used in the pilot scale circulating fluidized bed combustor at Chatham, N.B. Correlation was found between sulphur capture efficiencies and the sulphide content of the ash and elutriation losses.

0150 Economic, Industrial, and Business Aspects

Refer also to citation(s) 23264

23454 (ANL/EES-TM-305) **Regional economic forecasting models: Suitability for use in the National Acid Precipitation Assessment Program.** South, D.W. (Argonne National Lab., IL (USA). Energy and Environmental Systems Div.); McDonald, J.F.; Oakland, W.H. Argonne National Lab., IL (USA). Energy and Environmental Systems Div. Feb 1990. 91p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. Order Number DE90007898. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

In preparation for the Phase 1 test runs of the National Acid Precipitation Assessment Program Task Group B (TG-B) emissions model set, the need arose to provide regional economic data directly to the sector models in the model set and to the Argonne Regionalization Activity Module (ARAM). Candidate regional economic models were reviewed, and the Data Resources, Inc. (DRI), model was selected. This review of models, conducted during 1984–1985, is documented in this report. Even though considerable time has elapsed since then, the model descriptions and critique contained in this report are still fairly accurate and the recommendations should still be valid. There have been, however, some significant changes: (1) two of the economic consulting firms whose models were reviewed, Chase Econometrics and Wharton Econometric Forecasting Associates, have merged, (2) the DRI Regional Information System (DRI/RIS) now constructs a regional measure of industrial value of shipments, which will be used as the industrial activity variable (instead of employment) in the Phase 2 scenario analyses, and (3) based on recommendations from the third-party review of the TG-B model set, price-sensitive regional equations were developed to provide inputs, not already produced by the DRI/RIS model, directly to the sector models, thus eliminating the function served by ARAM. 44 refs., 12 figs., 44 tabs.

23455 (CONF-880770– II.3-II.7) **Coal: Targets of opportunity workshop, keynote address.** Bauer, D.L. Sheladia Associates, Inc., Rockville, MD (USA). Sep 1988. From Coal - targets of opportunity workshop; Washington, DC (USA); 12-13 Jul 1988. In *Coal: Targets of opportunity workshop: Proceedings.* Order Number DE89002076. Available from NTIS, PC A12/MF A01.

According to the author, outside of the utility sector, commercial coal technology today is outdated, outmoded, and in danger of becoming outdistanced by oil and gas technologies and by new, alternative energy technologies. For every 7 tons of coal burned in utility plants, only one ton is burned in the industrial market, and virtually none in the commercial, residential, and transportation sectors. The potential market is there, but new technology is needed. Possible steps in the right direction are coal liquids, pyrolysis, coal-water slurries, fluidized-bed combustion, and coal-fired turbines and diesel engines. This workshop needs to look at not just new ways to burn coal, but new ways to market coal.

23456 (CONF-880770– II.19-II.23) **Coal - targets of opportunity workshop, luncheon address.** Cope, J.A. Sheladia Associates, Inc., Rockville, MD (USA). Sep 1988. From Coal - targets of opportunity workshop; Washington, DC (USA); 12-13 Jul 1988. In *Coal: Targets of opportunity workshop: Proceedings.* Order Number DE89002076. Available from NTIS, PC A12/MF A01.

The paper first describes the positive aspects of the US coal industry: productivity, efficiency, product quality, and share of the fuel market. Problems in the coal industry are then addressed: coal price versus oil price, conservative approaches to investment by utilities, and competition from nuclear power plants. The author then discusses what all this implies for coal marketing. He closes with some market forecasts.

23457 (CONF-880770– III.57-III.68) **Coal-derived fuels as successful petroleum replacements and unique opportunities offered to US railroads.** Hapeman, M.J. (GE Transportation Systems, Erie, PA (USA)). Sheladia Associates, Inc., Rockville, MD (USA). Sep 1988. From Coal - targets of opportunity workshop; Washington, DC (USA); 12-13 Jul 1988. In *Coal: Targets of opportunity workshop: Proceedings.* Order Number DE89002076. Available from NTIS, PC A12/MF A01.

The commercialization of any new fuel form is a complex procedure. Lasting success at such a venture depends on several interrelated variables, including: competing fuel costs; technology development; the cost to change the infrastructure; and the willingness of the establishment to take the risk to make the change. Change to a new fuel form will not progress uniformly over the whole market, but rather the change will start from established islands that have particularly strong economic incentives. If the conversion in these islands is successful, then the change will spread to areas where sufficient economic incentive exists. US railroads offer the unique opportunity in becoming the initial islands of success from which a broader replacement of petroleum fuels can be developed. The past commercialization of petroleum fueled diesel engines on the railroads and then in trucks is reviewed to act as a framework for the commercialization of coal water mixture fueled diesel engines. The most probably scenarios for engine and locomotive development, coal water mixture fuel production, infrastructure change, and the role of Government, equipment manufactures, and the railroad customers are discussed.

0160 Health and Safety

Refer also to citation(s) 23399, 23400

02 PETROLEUM

Refer also to citation(s) 24164

23458 (OCS/MMS–90-0004) **Offshore scientific and technical publications: 1987 annual.** Bajusz, A.M. Minerals Management Service, Herndon, VA (USA). [1990]. 24p. Sponsored by U.S. Department of the Interior. Available from OSTI; Office of Offshore Information and Publications, Minerals Management Service, MS642,381 Elden Street, Herndon, VA 22070-4817.

This catalog lists 1987 scientific and technical publications of the Offshore Minerals Management Program. It is the fourth in a series of permanent catalogs listing each year's publications.

0202 Reserves, Geology, and Exploration

Refer also to citation(s) 23685

23459 (NIPER–320, pp. 13-42) **Reservoir assessment and characterization.** Cheng, A.; Honarpour, M.M.; Szpakiewicz, M. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

Analysis of geological, petrophysical, production, and pressure data from the producing Bell Creek field, and measurement of petrophysical properties of rock samples from an outcrop parallel and adjacent to the Bell Creek barrier bar were initiated. Statistical analysis of porosity and permeability distributions in the different bar facies (foreshore, shoreface, and lower shoreface) was conducted with subsurface data from the barrier bar at Bell Creek to determine the relative importance of the various facies in controlling fluid movement in the reservoir. A stratigraphic cross-section across the barrier bar deposit in Bell Creek field was constructed. A conceptual geological model of the barrier island (bar) deposit at Bell Creek field, Montana, was outlined in a four-section area enclosing the tertiary incentive project (TIP) area. The area selected for geological and production performance studies was a four-section area within production Unit A of the barrier island Muddy sandstone at Bell Creek field. From this 4-square mile (10.36 km^2) area, which includes the TIP pilot project area, log, well test, production, and core data were acquired for construction of a geological/engineering model of a barrier island reservoir. Results and details of methodology are described.

23460 (RISO-M–2819) **Physical concept and mathematical formulation of basin modelling.** Wilson Fugl, A. Risoe National Lab., Roskilde (Denmark). Energy Technology. Sep 1989. 67p. Order Number DE90760177. Available from NTIS (US Sales Only), PC A04/MF A01.

A physical and mathematical formulation to predict the generation, migration and accumulation of hydrocarbons during basin evolution is given. This involves fundamental conservation laws,

constitutive relationships, boundary conditions and physical properties of rock, water, oil and gas. The closure of the problem in relation to available geological data has been given a high priority compared to accuracy. Finally, some comments on solution technique are made. (author) 15 tabs., 3 ills., 23 refs.

23461 Investigation on the effects of organic solvent extraction on whole-rock pyrolysis: Multiple-lobed and symmetrical P_2 peaks. Tarafa, M.E. (Woods Hole Oceanographic Institute, Woods Hole, MA (USA)); Whelan, J.K.; Farrington, J.W. *Organic Geochemistry (UK),* 12(2): 137-149 (1988). DOE Contract FG02-86ER13466.

Pyrolysis techniques provide an estimate of oil-generating potential of a sediment based on the amount of P_2 (or S_2) hydrocarbons. Multiple-lobed and symmetrical P_2 peaks were studied to determine if extractable bitumen affected the P_2 results. Samples from the Tiglukpuk and Ledbetter wells were analyzed as whole, unextracted, ground sediment and after organic solvent extraction using pyrolysis techniques. Results indicate that P_2 for the Tiglukpuk well appears unaffected by solvent extraction. P_2 peaks for the Ledbetter well samples appear to include extractable bitumen or asphaltenes. Pyrolysis-gas chromatography (pyrolysis-GC) and pyrolysis-gas chromatography-mass spectrometry (pyrolysis-GC/MS) determined the composition of the portion of the P_2 peak for the Ledbetter well that was removed by organic solvent extraction. Pyrolysis-GC analysis also demonstrated that for the Ledbetter well gas-generating organic material was not removed by organic solvents.

0203 Drilling and Production

Refer also to citation(s) 23459, 23494, 23715, 23817, 24163, 24392

23462 (CONF-850710–, pp. 607-613) **Thermal EOR (enhanced oil recovery) - A review of insulated tubing and downhole steam generator materials evaluations.** Aeschliman, D.P. (Sandia National Labs., Albuquerque, NM (USA)); Moreno, J.B.; Marshall, B.W. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Enhanced oil recovery (EOR), as either thermal, chemical, or gas injection, accounted for about 5.3% of the US oil production in 1984. This represents a 23% increase in EOR production and a 36% increase in EOR projects compared to 1982. Of this total, thermal methods account for about 80%, with the majority of the thermal projects located in the relatively shallow, heavy oil fields of central and southern California. Thermal EOR is almost entirely steam injection from surface generators through either uninsulated or, more recently, insulated tubing. The US Department of Energy has sponsored a program at Sandia National laboratories (Sandia) with objectives of providing improved technology for more efficiently providing steam to the reservoir. This program involved technology assessment/development in two areas: (1) downhole steam generators and (2) improved thermal well completions. This paper gives a general background, describes the technology, and presents recent results from their current work in these two areas.

23463 (CONF-850710–, pp. 1199-1211) **Combustion in the circulating fluid bed and gasification as a means of environmentally acceptable energy generation from upgrading residues.** Schaub, G. (Lurgi GmBH, Frankfurt (West Germany)); Reimert, R.; Janssen, K.; Polanco, D.R.; Intevep, S.A.,. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A.. Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

In the context of an increasing need for residue utilization technologies, the most common residues from petroleum upgrading are reviewed with respect to their use as feedstocks for gasification and combustion. Results from test runs in a Circulating Fluid Bed (CFB) pilot plant demonstrate the application and high performance of the CFB-principle for the combustion of petroleum-derived residues rich in sulfur and heavy metals. These experiments were particularly aimed to generate data on carbon combustion efficiency, sulfur retention in the bed, and NO_x formation. For gasification, an assessment is presented of various available coal gasification processes that could be used to generate fuel gas from delayed coke, an increasingly important residue. Data from gasification test runs on a demonstration or pilot plant scale are reported for the British Gas-Lurgi Slagging Gasifier and the Circulating Fluid Bed (CFB) process, respectively. Finally, residue combustion with CFB technology and gasification, including product gas desulfurization and subsequent combustion, are compared. These are competing routes for the generation of steam in enhanced oil recovery, with respect to environmental and economic aspects.

23464 (CONF-850710–, pp. 1297-1305) **Asvahl hydrocatalytic process for heavy oil upgrading.** Bousquet, J. (Elf Aquitaine, St. Symphorien (France)); Devanneaux, J.; Peries, J.P. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

The ASVAHL hydrocatalytic process permits upgrading of many of the world's heavy, highly contaminated crudes to high quality, low sulfur products. This is illustrated by results derived from various feedstocks on the 15-20,000 tons/year Solaize mini-refinery. The development of a new catalytic system makes it possible to upgrade a very large proportion of heavy resids and to reduce, at the same time, the production of fuel oils.

23465 (CONF-850710–, pp. 1307-1315) **The MSR process for upgrading bitumens and heavy oils.** Swanson, R.C. (EECTS, Mitworhaven, NY (USA)); Samuel, W.A. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Tests using catalysts based on alkali metal sulfides have resulted in heavy feedstocks, including bitumens from the Orinoco Oil Belt and Alberta tar sands, being converted into valuable products under mild conditions. Most of the work was done at essentially atmospheric pressure, and the temperature was below 800°F. About two-thirds of the bitumen was routinely converted to a range of metals-free, −1,000°F materials using liquid hourly space velocities (LHSV) in the range 1.2-3.8. At somewhat more severe temperature conditions, higher conversions were obtained. Because reactor design is not yet optimized, it is believed that appreciably higher LHSVs will be achievable with good results. A second reactor stage provided similar conversion of the +1,000°F material from the first stage. Product quality and distribution were even more favorable. Although most of the work was performed at near atmospheric pressure, very recent tests have verified that pressures of 10 to 15 atmospheres could have very salutary

effects. The work indicates that it will be possible to process bitumens to produce light materials without employing high pressures or hydrogen gas. Although sound cost projections are not yet available, it appears that savings of several dollars per barrel are likely. The catalyst is relatively inexpensive and does not appear to lose appreciable activity. This, in conjunction with the relative simplicity of the system, offers great promise toward enhancing the value of highly viscous deposits, especially those that are remotely located.

23466 (NIPER–320, pp. 43-53) **TORIS (Tertiary Oil Recovery Information System) research support.** Madden, M.P.; Pautz, J.F.; Thomas, R. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

The US Department of Energy (DOE) as part of its program on Enhanced Oil Recovery (EOR) is making a continuing survey of the Nations potential for enhanced oil recovery. This is done through the Tertiary Oil Recovery Information System (TORIS). It involves obtaining data on the amount of oil that will be left in known reservoirs after conventional methods of recovery are completed and estimating how much additional oil could be recovered by applying enhanced oil recovery methods. NIPER assists the DOE by maintaining, evaluating, and improving components of TORIS. The system components involved are: data bases of information on EOR projects, data bases of information on oil reservoirs, and a suite of computerized EOR predictive models. Continuing work in FY87 includes the addition of newly initiated EOR projects to the data bases; maintaining, improving, and updating of data already in the data bases; implementing a new data base management system for the EOR project data; and evaluation of new and modified predictive models. Details of the project are given.

23467 (NIPER–320, pp. 65-81) **Maintaining surfactant slug integrity.** Burchfield, T.E.; Noll, L.A.; Olsen, D.K. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

Phase behavior of carboxymethylated ethoxylates was briefly summarized and the phase behavior of some amine oxides, though not cosurfactant free, were also included. Commercial amine oxide surfactants were screened for structure/performance determining oil solubilization, phase behavior, salinity tolerance, and oil recovery. Adsorption calorimetry of methanol from heptane and from toluene, and toluene from heptane was completed. The enthalpies of replacement are in this order: methanol/heptane > methanol/toluene >> toluene/heptane. Adsorption calorimetry of surfactant from solutions with added electrolyte confirmed that the adsorption increases more sharply and plateaued at higher values than in the case of no added salt. The Woodbury-Noll adsorption model was simplified so that the fitting of binary adsorption data requires one less parameter. The extension to three-component systems was proceeding as scheduled. The addition of electrolyte to surfactant solutions at high temperatures was found to lower the critical micelle concentration (CMC) region. Enthalpies of dilution of dodecyltrimethylammonium bromide in 0.05 to 0.2 molal sodium bromide was measured at 373 K. Details of these studies are presented.

23468 (NIPER–320, pp. 83-98) **Surfactant-enhanced alkaline flooding.** Burchfield, T.E.; Olsen, D.K.; Thornton, S.D. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

Several studies were made to investigate the reported effect of sodium bicarbonate on interfacial tension (IFT) of Wilmington crude oil. The effect of sodium bicarbonate on biopolymer adsorption was measured along with the IFT. Emulsification and coalescence of Wilmington crude oil emulsions were studied. Coalescence times and IFT measurements were obtained for Wilmington crude oil in sodium bicarbonate brines with various concentrations of added synthetic surfactant and polymer. Oil displacement results indicated that although polymer has a negative effect on IFT and coalescence, the requirement for mobility control in the slug outweighs the adverse effect of polymer on IFT and coalescence. The effectiveness of various injection strategies and pH on oil displacement and IFT was reviewed and the results indicated that a surfactant-enhanced carbonate system recovered more oil and was more cost effective in laboratory tests than a surfactant-enhanced bicarbonate system of equivalent salinity. However, this is misleading because the results from comparison of these surfactant systems in cores cannot be extrapolated to field scale results because of differences in contact times. Consumption of sodium carbonate is very significant for contact times commonly encountered in reservoirs.

23469 (NIPER–320, pp. 99-111) **Mobility control - Basic rheological studies.** Burchfield, T.E.; French, T.R.; Gao, H.W. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

In order to identify polymer rheological characteristics that were optimal for the displacement of fluids from porous media, a series of tests were made on a Berea sandstone core and a high clay sandstone core. Flow resistance measurements were made with a Newtonian fluid (glycerin) and a non-Newtonian fluid (Pusher-500) in 10-in cores. Viscoelastic effects were seen only at high flow rates. For tracers, fluorescein and bromocresol green were chosen. Displacement tests were made in a 4-ft Berea sandstone core using 1,500 ppm Pusher-500, a polyacrylamide polymer, and 63 wt% glycerin at two flow rates, one in the viscoelastic flow regime and one in the purely viscous flow regime. Comparisons of the effluent concentration profiles indicated that a Newtonian fluid provided a more stable displacement at the leading edge where the mobility ratio was favorable than a non-Newtonian fluid. At the trailing edge where the mobility ratio was unfavorable, a Newtonian fluid showed less viscous fingering than a non-Newtonian fluid in the purely viscous flow regime. In the viscoelastic flow regime, a non-Newtonian fluid gave a less viscous fingering effect than a Newtonian fluid.

23470 (NIPER–320, pp. 113-128) **Gas miscible displacement.** Burchfield, T.E.; Chung, T.H. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

Slim tube minimum miscibility pressure tests were made on various crude oils and mixtures of hydrocarbons. An empirical correlation was developed which calculated the MMP for the fourteen samples with an average deviation of 2.3%. An apparatus to determine the solubility of potential entrainers in gaseous nitrogen or carbon dioxide was constructed. The solubility and resulting viscosity of n-decanol, isooctane, and 2-ethylhexanol in supercritical carbon dioxide was measured. A high pressure coreflooding apparatus was assembled to facilitate the coreflooding experiments. Seven corefloods were run on the same recombined Lake Barre reservoir oil utilizing various strategies. Secondary nitrogen injection in a gravity-stable mode recovered the most oil. Secondary nitrogen injection in a gravity-unstable mode resulted in the next highest recovery. Tertiary nitrogen injection in a gravity-stable mode gave the poorest performance and resulted in less oil from waterflood and nitrogen flooding than was obtained just by nitrogen flooding. Experiments utilizing a surfactant to produce foam was unsuccessful in improving mobility control and this was possibly due to a poor choice of surfactant.

23471 (NIPER–320, pp. 129-139) **Residual oil saturation measurement and estimation improvement.** Cheng, A.; Maerefat, N.L.; Mahmood, S.; Chang, M.M. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

Electrical resistance measurements were made on fully and partially brine-saturated cores at different temperatures and pressures. The values obtained were used to investigate the effects of confining pressure and temperature on the cementation factor (m) and the saturation factor (n) in Archie's equation. The results showed that the electrical resistivity measurements varied with temperature and confining pressure and that cementation factor and saturation

exponent measured at laboratory conditions were not the same as those measured at reservoir conditions. This effect was observed even after correcting for changes in porosity and saturation due to pressure and temperature variations. Temperature and confining pressure also had some effect on the electrical resistivity measurements of carbonate rocks. The cementation factor and saturation exponent changes with temperature and confining pressure. The changes were more pronounced for carbonate rocks than sandstones, and carbonate rocks required a longer equilibration time. In addition to the equilibrium time, the confining pressure and temperature at which the carbonate rocks were saturated also affected the cementation factor and saturation exponent. The effects of hysteresis and pore pressure on electrical resistivity were also studied. The results presented here only outline a portion of the major findings reported previously.

23472 (NIPER–320, pp. 141-150) **Three-phase relative permeability.** Cheng, A.; Maerefat, N.L.; Parmeswar, R. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

Cores were prepared for use in the three-phase permeability work. The TPKR model was adapted to a multipurpose reservoir simulator. Displacement tests were run and these data were used to compute three-phase relative permeabilities using the multipurpose reservoir simulator (unsteady-state method). Steady-state three-phase relative permeability data were obtained on a low oil-viscosity system and a high oil-viscosity system. An analysis of the shapes of the isoperms was made and indicated that brine relative permeability when three phases are present is a function of its own saturation only. However, the brine permeability in the presence of high viscosity oil was lower by a factor of 10. It is noted that oil relative permeability is a function of all three fluid saturations, and as the oil viscosity increases, the oil relative permeability shows less dependence on the brine and gas saturations. Gas relative permeability is a function of all three saturations and the influence of oil saturation on gas relative permeability increases with an increase in oil viscosity. Attempts to implement an x-ray absorption technique for the simultaneous measurement of oil and water phase saturations were unsuccessful because of limitations on the x-ray equipment available.

23473 (NIPER–320, pp. 151-161) **Thermal processes for light oil recovery.** Madden, M.P.; Strycker, A. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

As a result of a literature search, work was done to establish the effect of gravity override on steamflooding of light-oil reservoirs, and to determine the effects of temperature on capillary pressure. Gravity override effects on light oil were found to be substantial although not as great as with heavy oil. Centrifuge experiments suggested that core/fluid systems became more water-wet at high temperatures and this effect could contribute to better recoveries. The addition of a siloxane (DF-104), asphaltenes, or polar compounds to the oil produced cores that were more oil-wet.

23474 (NIPER–320, pp. 163-170) **Thermal processes for heavy oil recovery.** Madden, M.P.; Strycker, A. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

Increased oil production has been observed as the result of the addition of surfactants during steamflood operations. Some controversy exists about the mechanism by which surfactants enhance oil production with steam. A better understanding of the mechanisms of oil production with steam and surfactants would enable improvement of the process. The purpose of this project is to improve the effectiveness of surfactant additives as sweep and mobility control agents in reservoir steam methods. A literature search for the best methods for measuring foam stability at high temperatures was made. A critical evaluation of experimental procedures was completed. The measurement of the rate order of foam degradation was undertaken on a group of surfactants choosing temperatures to minimize the effect of extraneous processes. The standard rate equation was shown to be effective in the high temperature-pressure test. The value of the rate order, n, was 0.0 for relatively fast degradation rates and appears to increase with decreasing temperature.

23475 (NIPER–320, pp. 171-175) **Development of surfactants as profile modification agents.** Burchfield, T.E.; Olsen, D.K. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

The goal of this research was to develop a profile modification system that would provide in-depth, preferential penetration into the highly permeable zones that were swept by water, reduce the permeability in that region, and thus provide improved sweep efficiency. A series of five amine oxides, PF-1 thru PF-5, based upon commercially available amine oxides, were mixed with short-chain, water-soluble alcohols ranging in carbon chain length from methanol to isoamyl alcohol, in a brine corresponding to that of produced water from North Burbank field, Osage County, Oklahoma. Stabilities and viscosities were determined. From high performance liquid chromatography, HPLC, a rough order of elution from a silica gel column was obtained with a mixed solvent system of methanol, water and acetonitrile. As an example, the order of elution of PF-1 with alcohols was found to be methanol, ethanol, propanol, isopropanol, PF-1, isobutanol, and isoamyl alcohol. The order of elution provided only a relative ordering of chromatographic separation since the column did not contain a hydrocarbon phase such as crude oil, nor was the elutant a brine that could be used for a waterflood. Phase-inversion-temperature (PIT) measurements were conducted on several of the formulations to help prevent the formation of water-in-oil emulsions when the surfactant-alcohol blend contacted crude oil at the reservoir test conditions of 50°C. North Burbank Unit (NBU) stock tank oil was used in both PIT and oil-displacement experiments. The details of these experiments are presented.

23476 (NIPER–320, pp. 177-182) **Development of improved immiscible gas displacement methodology.** Burchfield, T.E.; Chung, F.T.H. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

An investigation of the feasibility of using carbon dioxide flooding on the East Eucutta field (Mississippi) was carried out. Coreflooding tests were run on the reconstituted Eucutta crude using continuous CO_2 injection, waterflood, continuous CO_2 flood after waterflood, and CO_2-alternate-brine flood (CO_2-WAG). Each of the modes using CO_2 recovered more oil than the waterflood, and the CO_2-WAG procedure was the most effective.

23477 (NIPER–320, pp. 183-196) **Experimental support for mineral/alkali reaction model.** Burchfield, T.E.; Olsen, D.K.; Peru, D.A.; Thornton, S.D. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

The reaction with alkali of two reservoir sandstones (Liao-He and Gu-Dao) from the Peoples Republic of China was measured. X-ray analysis indicated that Liao-He sandstone contains 10% clay and Gu-Dao sandstone contains 16% clay. Results of a 2-wk bottle test at 60°C provided kinetic information for Liao-He sandstone. The Liao-He sandstone dissolved 87 ppm Al and 450 ppm Si into 0.5 N NaOH solution. Results of a slim tube experiment demonstrated the consumption of sodium hydroxide by a reservoir sandstone which involved both fast reactions and slow reactions. Injection of 0.5 N NaOH solution into Gu-Dao reservoir sandstone continued for 3 mo. The fast reactions were combinations of ion exchange and dissolution of soluble minerals followed by precipitation of minerals containing calcium and magnesium. The slow reactions were transformations of clay minerals into sodium aluminosilicates. A second slim-tube experiment on the reaction of alkali with reservoir sandstone was completed. Injection of 0.5 N Na_2CO_3 solution into

Liao-He reservoir sandstone continued for three months. The sandstone consumed 0.0055 equiv/kg of sand of alkalinity by ion exchange between 1.0 and 1.4 PV injected. Both calcium and magnesium were removed from the solution by alkali. Mineral reactions in alkaline flooding were accurately represented by a series of slim-tube experiments. These slim tubes, packed with Wilmington sandstone, were flooded with solutions containing the following alkalies: $NaHCO_3$, Na_2CO_3, and Na_4SiO_4. Alkalinity and pH of the effluent followed trends in agreement with the geochemical model developed in Project BE4B (NIPER-206) and match those of the alkaline field test in Wilmington field conducted in the late 1970s and early 1980s.

23478 (NIPER–320, pp. 205-207) **Evaluation of methods to determine liquid levels in the annulus of injection wells.** Madden, M.P.; Collins, A.G. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

The Underground Injection Control (UIC) program, administered by the US Environmental Protection Agency (EPA), requires injection well operators to test the mechanical integrity of Class II injection wells. Class II injection wells are those that involve the underground injection of brine and other fluids brought to the surface in connection with (1) conventional oil or gas production and which might be commingled with hazardous wastes from gas plants that are an integral part of production operations, (2) injection of fluids for enhanced oil recovery operations, and (3) injection for storage of hydrocarbons that are liquid at standard temperatures and pressures. Testing is necessary to ensure that the injected fluids are placed into the target formation without significant leakage to other strata. Initially, the goal was to secure an agreement with an operator in Osage County to emplace a bottomhole pressure device in a Class II, packerless-completed injection well for testing. When this was not feasible, arrangements were made to use a well in Nowata County. A report was prepared detailing the features of the field in which the test was to be made.

23479 (NIPER–320, pp. 209-217) **Microbial-enhanced waterflood field experiment.** Burchfield, T.E.; Bryant, R.S. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

A microbial-enhanced waterflood field project sponsored by the US Department of Energy (DOE), Microbial Systems Corp. (MSC), and INJECTECH, Inc., and conducted in cooperation with the National Institute for Petroleum and Energy Research (NIPER), was initiated in October 1986. The site was operated by B and N Oil Co., Nowata, OK, and consists of four adjacent inverted five-spot patterns drilled on a five-acre spacing in the Mink Unit of Delaware-Childers field. A baseline monitoring phase prior to microbial injection was conducted from October 1986 to March 1987. Field samples were collected weekly and analyzed for microbial populations, oil viscosities, total dissolved solids (TDS), trace mineral concentrations, and pH. Sampling results are presented.

23480 (NIPER–320, pp. 219-233) **Simulation of production from wells with horizontal/slanted laterals.** Chang, M.M.; Tomutsa, L.; Tham, M.K. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

Modifications were made to the simulator BOAST and the modified BOAST was tested for use on horizontal and slanted wells. Comparison of BOAST results with those of published methods indicated that the modified BOAST gave satisfactory results. The simulator was then tested using the information and production data of a field in New Mexico where a horizontal well was drilled in 1979. The simulated results showed that the horizontal well would produce more oil than three offset conventional wells.

23481 (NIPER–320, pp. 235-243) **Development of crosslinking technology for biopolymers.** Burchfield, T.E.; French, T.R.; Gao, H.W. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

Profile modification is one way to increase reservoir sweep efficiency and produce more crude oil. Combining powdered biopolymer with a crosslinking agent will result in a profile modification system that can be economically used by small lease operators. Two of the properties necessary to develop a dry biopolymer/crosslinker mixture are to establish filterability and gel stability. Filterability tests performed with a new filtration apparatus and North Burbank Unit (NBU) brine confirmed that 60 min mixing time was sufficient to fully hydrate and mix the dry, powdered biopolymer. Crosslinker systems that produce stable gels were identified. Those systems were chromium chloride crosslinker and chromium/thiourea crosslinker.

23482 (NIPER–320, pp. 245-246) **Symposium on application of microbial technology in oil production.** Burchfield, T.E.; Bryant, R.S. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

Microbial enhanced oil recovery basically encompasses two major topics: the formation (oil-producing zone) and the microorganisms. The design and performance of a microbial enhanced oil recovery (MEOR) project depend, in part, on reservoir properties and heterogeneities and on the specific mechanisms of oil mobilization. Through laboratory procedures, microbial formulations can be optimized for each specific reservoir. A short course entitled Improving Oil Recovery by Use of Microorganisms was conducted August 11, 1987 with 109 registrants. A symposium entitled Applications of Microorganisms to Petroleum Technology was held August 12-13, 1987 with 125 registrants to hear the 17 papers. Both the short course and the symposium were held in Bartlesville, OK. The registrants came from four foreign countries and 14 states.

0204 Processing

Refer also to citation(s) 23265, 23516, 23518, 23533

23483 (NIPER–320, pp. 355-388) **Fate of problem-causing compounds during upgrading of heavy fossil fuels.** Anderson, R.P.; Green, J. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

In order to determine the effectiveness of upgrading by hydrotreating, several series of catalytic cracking experiments were run on Mayan gas oil and on its upgraded products at three levels of hydrotreating. The lowest level improved the crackability but more severe hydrotreating was not effective in improving yields. This contrasted with similar work on Wilmington gas oil where increasing severity of hydrotreating continued to improve yields. Acid subfractions from a hydrotreated product were analyzed by high resolution mass spectrometry and were found to be predominantly carbazoles and other benzo-derivatives of pyrrole. The analysis of sulfur and nitrogen in hydrotreated products which had been separated into acids, bases, and neutrals revealed that nitrogen compounds in the neutrals were more resistant to hydrotreating than either acidic or basic nitrogen compounds. To examine these compounds a method originally designed to separate sulfides from aromatics was employed. This test showed that while polar neutrals from Wilmington decrease with increasing severity of hydrotreating, those from Mayan distillate increased.

0207 Economic, Industrial, and Business Aspects

23484 (CMI-R–89/30150-2) **Invariant controls in stochastic allocation problems.** Olsen, T.E.; Stensland, G. Christian Michelsens Inst. for Vitenskap og Aandsfrihet, Bergen (Norway). Oct 1989. 19p. Order Number DE90760264. Available from NTIS (US Sales Only), PC A03/MF A01.

In this report we identify situations in which an uncertain price process does not influence the optimal policy in stochastic allocation problems. Such problems typically emerge in evaluation of offshore petroleum production projects. 14 figs.

23485 (CMI-R–89/30150-3) **Some applications of dynamic programming to natural resource exploitation.** Stensland, G.; Tjoestheim, D. Christian Michelsens Inst. for Vitenskap og Aandsfrihet, Bergen (Norway). Oct 1989. 28p. Order Number DE90760263. Available from NTIS (US Sales Only), PC A03/MF A01.

Two evaluation models of investment in natural resource exploitation are presented. The first concerns the option of opening a copper mine, and the subsequent evalution under uncertain prices. The second example deals with the evalution of an oil field in the presence of uncertain production profiles. 21 refs., 1 fig., 4 tabs.

23486 (DOE/EIA–0520(90/03)) **International petroleum statistics report, March 1990.** USDOE Energy Information Administration, Washington, DC (USA). Office of Energy Markets and End Use. 28 Mar 1990. 36p. Sponsored by U.S. DOE Management & Administration. Order Number DE90008853. Available from NTIS, PC A03/MF A01 - GPO - OSTI; GPO Dep.

This report presents data on international oil production, consumption, imports, exports, and stocks. The report has three sections. Section 1 contains time series on world oil production, and on oil consumption and stocks in the Organization for Economic Cooperation and Development (OECD). This section contains annual data beginning in 1973, and monthly data for the most recent two years. Section 2 presents an oil supply/consumption balance for the market economies (i.e. non-communist countries). This balance is presented in quarterly intervals for the most recent two years. Section 3 presents data on oil imports by OECD countries. This section contains annual data beginning in 1982, and quarterly data for the most recent two years. 23 tabs.

23487 (NEI-NO–102, pp. 12) **Perspectives in offshore industry.** Christiansen, O.K. Norsk Petroleumsforening, Oslo (Norway). 1987. (In Norwegian). (CONF-8703333–: Installation and maintenance of subsea production system, Haugesund (Norway), 16-18 Mar 1987). In *Installation and maintenance of subsea production systems, Haugesund (Norway), 16-18 Mar 1987.* Order Number DE90760265. Available from NTIS (US Sales Only), PC A20/MF A01.

The present paper gives a future perspective of the oil activity on the Norwegian continental shelf. Following aspects are discussed: the economic consequences to come; new trends in the offshore market; reconstruction of the offshore industry.

0208 Waste Management

Refer also to citation(s) 23478

23488 (NEI-DK–277) **Manual and test results regarding development of measuring apparatus for determination of oil content of process water.** Eisum, N.; Hansen, H.P.; Simonsen, C.; Lynggaard-Jensen, A. Vandkvalitetsinstituttet, Hoersholm (Denmark). 1989. 76p. (In Danish). Contract EM-1313/88-4. Order Number DE90760230. Available from NTIS (US Sales Only), PC A05/MF A01.

EFP-88.

The aim was to develope an optical instrument for the measurement of the content of oil and phenol in industrial process water. The measuring instrument utilizes a computer. The sensor is constructed in such a way that it can be directly connected to the flow of process water. The optical measurement takes place just above the surface of the water to avoid dirtying of the optical windows. The computer unit which steers the sensors is encapsuled in a unit which can shut itself off in the case of an emergency in such a way that it answers to requirements related to safety in the event of an explosion. The instrument proved to very sensitive even to minimal concentrations of phenol, but had difficulty in registering the highest concentrations. The system is described and methods of using the measuring apparatus in relation to the computer system are presented in detail. Graphs of measurement results illustrate the text. (AB).

23489 (NIPER–320, pp. 339-353) **Refinery groundwater studies.** Brinkman, D.W.; Wells, J.W. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A22/MF A01.

During FY86, project personnel compiled a report Groundwater Contamination from Refinery Operations (NIPER-175) which detailed the state of the art in groundwater research relating to refinery operations. The report generalized the needs for research into six broad categories. These were: (1) analytical procedures for determining the amounts and types of trace organic compounds found in groundwater; (2) monitoring technique and equipment which accurately reflect the contents of an aquifer; (3) methods for detecting the existence of hydrocarbons in the environment which could contaminate groundwater; (4) the fate and transport of contaminants in the soil and groundwater; (5) aquifer restoration; (6) prevention of contamination by limiting the amounts of waste developed and by improving disposal techniques. The development of a model simulating the flow of oil through the unsaturated zone immediately below the surface of the land was completed. This involved problem definition, model development, and program development. The problem definition developed the physical concept of the process; the model development consisted of application of mathematical procedures to the process and development of flow equations. The program development provided a Fortran computer program to solve the equations.

23490 (NIPER–320, pp. 431-434) **Recovery of navy distillate fuel from reclaimed product.** Brinkman, D.W.; Wells, J.W. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

For more than a decade NIPER scientists have been investigating the reclaiming of used or contaminated hydrocarbon mixtures both for economic and environmental advantages. A current problem is the recycling of Navy marine diesel fuel after contamination by sea water and other materials. The upgrading of the contaminated fuel back to specification product would result in augmenting the supply of diesel fuel as well as being superior to its use for fuel oil. Development work for designing a process to reclaim contaminated Naval Distillate Fuel has been completed. A full scale engine test of reclaimed fuel was made to ensure that no unforeseen changes in fuel characteristics had occurred that would have an impact on engine deposits, wear, or performance. The only problem surfacing was an increased elastomer swelling rate. A report from another laboratory indicated that the reclaimed fuel was no worse than other diesel fuels.

0209 Environmental Aspects

Refer also to citation(s) 23521, 24392

23491 (AD-A–215429/2/XAB) **Numerical modeling of contaminant transport with rate-limited sorption/desorption in an aquifer. Master's thesis.** Huso, R.C. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Dec 1989. 66p. (AFIT/GCS/ENC–89D-2). Available from NTIS, PC A04/MF A01.

Years of accidental or deliberate dumping of petroleum products and hazardous waste materials has resulted in polluted groundwater. The Department of Defense is engaged in a massive program, known as the Installation Restoration Program, to cleanup these polluted environments on military installations, and the Environmental Protection Agency is funding research to help in the cleanup efforts. These cleanup efforts often involve drilling wells in the vicinity of the contaminated area and evacuating water until the concentration of pollutant is reasonably low. The planners at these remediation sites use tools to estimate how long the wells must operate based on some initial sample data and sound judgement.

23492 (DOE/ER/60773–T1) **Fundamental quantitative analysis of microbial activity aquifer bioreclamation: Technical progress report, March–October 1989.** Rittmann, B.E. (Illinois Univ., Urbana, IL (USA). Dept. of Civil Engineering); Baveye, P. Illinois Univ., Urbana, IL (USA). Dept. of Civil Engineering. [1990]. 39p. Sponsored by U.S. DOE Energy Research. DOE Contract

FG02-89ER60773. Order Number DE90008696. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The project report contains two types of reports. The first type is a quarterly internal progress report. The purpose of the internal reports is to keep all members of the research team abreast with developments in each area. The second type is a semi-annual report that is transmitted to DOE and PNL. Its main purpose is to inform the project sponsors of the research-team's progress and plans. This report is the first semi-annual report. The project has four primary areas: biodegradation of poorly soluble organic contaminants, dual-limitation kinetics of electron donors and acceptors, two-dimensional modeling of biofilm reactions in nonhomogeneous porous media, and biologically induced clogging in porous media. Progress and plans for each are described. 28 refs., 14 figs.

23493 (LBH–488-566) **Vancouver oxidants study: Control technology options and costs for volatile organic compounds emissions from gasoline marketing.** Edwards, W.C.; Lee, N.P. Levelton (B.H.) and Associates Ltd., Vancouver, BC (Canada). May 1988. 217p. (MICROLOG–90-00023). Available from PC British Columbia Legislative Library, Government Documents Division, Parliament Buildings, Victoria, BC, CAN V8V 1X4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A series of studies was recently completed on the emissions of contaminants to the atmosphere in the lower mainland of British Columbia, and, as part of this program, a study was completed which prepared a computerized inventory of the sources and emissions of volatile organic compounds(VOC) for the gasoline marketing network, describes the sources of VOC emissions (storage of gasoline, bulk transfer of gasoline and refueling of motor vehicles), and discusses fuel quantities and emissions for the various sources. The source types having the top 4 annual emission levels (automobile service stations, bulk terminal truck loading, barge and ship loading, and fixed-roof tanks) were selected to study the control options; these sources emitted 81.4% of the annual total of 6517 tonnes emitted in 1985. The characteristics of these sources are discussed. The control options are compared for gasoline storage tanks (fixed roof and flooding roof), for the bulk transfer of gasoline, and for service stations. The reduction of the Reid vapor pressure and of toxic emissions (benzene) are also discussed. The estimate possible reductions of VOC emissions and the cost of these measures are calculated. The cost effectiveness of various VOC emission control strategies are compared, and recommendations are made for further study. 39 refs., 50 figs., 64 tabs.

23494 (NIPER–320, pp. 55-63) **Environmental impacts of microbial enhanced oil recovery processes.** Burchfield, T.E.; Bryant, R.S. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

Of all the enhanced oil recovery processes, microbial EOR (MEOR) is perhaps the least developed technologically. Microorganisms can be used in various ways to increase the recovery of oil. They may be used to manufacture, in surface operations, biosurfactants and biopolymers for EOR operations. They can also be injected into the formation with nutrients which permit them to multiply and form these compounds in situ as well as to produce gas which may increase the pressure in the oil formation. The use of these materials brings a whole new set of environmental problems because so little is known about the biological activity of the materials. The possibility of non-degradable or toxic by-products is one which merits investigation. Experiments were performed in Berea sandstone cores to examine what effects the growth and survival of Desulfovibrio desulfuricans, a sulfate-reducing bacterum, was having on the survival and ability of Bacillus and Clostridium spp. to recover incremental residual crude oil. Results based on the core studies indicated that Bacillus species survived and overgrew the Desulfovibrio sp. more consistently than the Clostridium species. In addition, the ability of Bacillus to recover residual oil was less diminished by the Desulfovibrio than it was for the Clostridium species. Many of the core results indicated that the injected bacterial systems could overgrow and eliminate the growth of the sulfate-reducing bacteria. This finding was of importance to MEOR applications because the reduction of sulfate-reducing bacteria by the injection of microbial strains could aid in solving the problems of corrosion and well damage in oilfield operations.

23495 (PB–90-126434/XAB) **Preliminary data summary for the coastal, onshore, and stripper subcategories of the oil-gas extraction point-source category.** Troy, K.S. Environmental Protection Agency, Washington, DC (USA). Office of Water Regulations and Standards. Sep 1989. 18p. (EPA–440/1-89/105). Available from NTIS, PC A03/MF A01.

The summaries contain engineering, economic and environmental data about industrial facilities in various industries discharging pollutants in their wastewaters and considers whether the EPA should pursue regulations to control such discharges. The summaries were prepared in order to allow EPA to respond to the mandate of Section 304(m) of the Clean Water Act. Summaries for categories already subject to rulemaking were developed for comparison purposes, and contain only the minimum amount of data needed to provide some perspective on the relative magnitude of the pollution problems created across the categories. The document is on coastal, onshore, and stripper subcategories of the oil and gas extraction industry.

23496 (PB–90-126509/XAB) **Preliminary data summary for the used-oil reclamation and re-refining industry.** Troy, K. Environmental Protection Agency, Washington, DC (USA). Office of Water Regulations and Standards. Sep 1989. 152p. (EPA–440/1-89/014). Available from NTIS, PC A08/MF A01.

The summaries contain data about industrial facilities in various industries discharging pollutants in their wastewaters and considers whether the EPA should pursue regulations to control such discharges. The summaries were prepared in order to allow EPA to respond to the mandate of Section 304(m) of the Clean Water Act. Summaries for categories already subject to rulemaking were developed for comparison purposes. The report is part of the process by which EPA is considering what management standards may be appropriate for the recycling of used oil, in response to the requirements mandated by these Acts. The study has attempted to characterize and profile the Oil Reclaimer/Re-Refining Industry. The goals of this preliminary effort were to: conduct a literature review, perform an industry profile, site visit re-refiners, screen sample re-refiners, and develop a Preliminary Data Summary.

23497 (PB–90-136169/XAB) **Health assessment for PSC Resources, Inc., Palmer, Massachusetts, Region 1. CERCLIS No. MAD980731483. Final report.** Massachusetts Dept. of Public Health, Boston, MA (USA). 18 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

The PSC Resources, Inc. site is listed by the U.S. Environmental Protection Agency (EPA) on the National Priorities List (NPL). The 3.6-acre PSC Resources, Inc. site is located at 10 Water Street, Palmer, Massachusetts. A waste oil refinery and solvent recovery plant operated on-site until the facility was abandoned by the owner in 1978. Millions of gallons of waste were left behind in tanks and lagoons. Contamination of soil, surface water and ground water occurs on-site. Soil contamination includes polychlorinated biphenyls at concentrations up to 30 ppm and lead. Surface water present in dikes contained lead and benzene. Oil sampled in the dikes contained cadmium, lead, benzene and PCBs. Oil found in a rainwater catchbasin contained Aroclor-1242 and tetrachloroethylene. Shallow ground water contamination consisted mostly of volatile organic compounds including 1,1,1-trichloroethane (40 ppm), trichloroethylene, benzene, methylene chloride, trans-1,2-dichloroethylene and tetrachloroethylene. Off-site contamination data is scant, as the Remedial Investigation has not been completed. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to significant levels of hazardous substances via the interception of contaminated ground water by private residential wells, the possible transport of contaminants off-site during flood events, and the recreational use of the nearby wetland and Quaboag River.

23498 (PB–90-138025/XAB) **Health assessment for McKin Company National Priorities List (NPL) Site, Gray, Cumberland County, Maine, Region 1. CERCLIS No. MED980524078. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 5 May 1989. 16p. Available from NTIS, PC A03/MF A01.

The McKin Company NPL Site, located near Gray, Maine, formerly stored, treated, and disposed of industrial and petroleum wastes. Volatile organic compounds (VOCs) and non-volatile compounds, including petroleum constituents, were detected in site soils. The remediation was completed in 1987 except for groundwater treatment. The groundwater treatment system portion of the remediation is currently in the planning stage. No monitoring data are presently available to confirm the existence or extent of potential off-site contaminant transport via the air pathway, and its impact on surface soils and related food chain entities, if any. Therefore, the likelihood of exposure through these pathways, if any, and its public health implications can not be evaluated at this time.

23499 (PB–90-140609/XAB) **Health assessment for Dubose Oil Products, Escambia County, Cantonment, Florida, Region 4. CERCLIS No. FLD000833368. Preliminary report.** Florida State Dept. of Health and Rehabilitative Services, Tallahassee, FL (USA). 19 Apr 1989. 7p. Available from NTIS, PC A02/MF A01.

The Dubose Oil Products National Priorities List Site is located in Cantonment, Florida. The site consists of a process facility located on the southern side and three bermed ponds located on the northern side of the site. The site was an oil recovery facility which operated from early 1979 through November 1981. A number of waste materials have been handled on the site including waste oils, petroleum refining waste, wood treatment process waste, spent solvent, spent pickle liquors, and various paint wastes. The contaminants of concern at Dubose Oil Products Site consist of iron, aluminum, manganese, 1,1-dichloroethene in groundwater and iron in surface water. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances at concentrations that may result in adverse health effects. Human exposure to 1,1-dichloroethene and iron may occur through ingestion of contaminated groundwater.

23500 (PB–90-141458/XAB) **Health assessment for Peak Oil, Hillsborough County, Tampa, Florida, Region 4. CERCLIS No. FLD004091807. Preliminary report.** Florida State Dept. of Health and Rehabilitative Services, Tallahassee, FL (USA). 19 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

The Peak Oil National Priorities List (NPL) site is located south of the Reeves Southeast NPL site and east of the Bay Drum NPL site. Peak Oil facility operations involved the use of a re-refining process to purify used oils and lubrication fluids. The contaminants of concern in the surficial aquifer are: barium, benzene, cadmium, copper, chlorobenzene, chromium, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, 2,4-dimethylphenol, lead, mercury, methyl ethyl ketone, methyl isobutyl ketone, methyl isopropyl ketone, nickel, PCB, tetrachloroethene, toluene, 1,1,1-trichloroethane, trichloroethene, waste oil, and xylenes. Soils/sludge on-site contaminants are: Arsenic, lead, and PCBs. Surface water off-site contaminants are: lead, oil and grease, strontium, and zinc. The site is considered to be of potential public health concern because of the risk to human health caused by exposure to hazardous substances via surface water runoff and percolation of contaminants into the Floridian aquifer.

23501 (PB–90-141474/XAB) **Health assessment for Petroleum Products Company Site, Broward County, Pembroke Park, Florida, Region 4. CERCLIS No. FLD980798698. Final report.** Florida State Dept. of Health and Rehabilitative Services, Tallahassee, FL (USA). 24 Apr 1989. 20p. Available from NTIS, PC A03/MF A01.

The Petroleum Products Company was located in Pembroke Park, Broward County, Florida. In 1985, the site was converted to the Pembroke Park Mini-Warehouses, where most of the rented mini-warehouses have been converted to small industrial businesses. Surficial and intermediate groundwater at the site are contaminated with lead, chromium, aluminum, iron, manganese, and benzene. A 20-inch thick waste oil layer is floating on the surficial aquifer beneath the mini-warehouses. Surface run-off water is contaminated with lead. Surface soil and deep soil at the site and from the surrounding areas have been found to contain high levels of lead. The site is of potential public health concern because contaminants are found in off-site surficial and intermediate aquifers and in off-site surface soils. The population at risk are employees of businesses at the site and the residents who live in the nearby trailer parks. Exposure may occur through contact with waste oil that seeps up to the surface and with lead in surface soil and surface water run-off.

23502 (PB–90-143611/XAB) **Health assessment for Bruin Lagoon National Priorities List (NPL) Site, Bruin Borough, Butler County, Pennsylvania, Region 3. CERCLIS No. PAD980712855. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 26 Apr 1989. 18p. Available from NTIS, PC A03/MF A01.

The Bruin Lagoon is a National Priorities List site. Because of past on-site disposal practices for wastes from a mineral oil refinery (not located on-site), heavy metals, inorganic compounds, and benzene have contaminated on-site groundwater, soils, and sludge material (in the lagoon). The site is of potential public health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects.

23503 (PB–90-145798/XAB) **BIOPLUME (biodegradation in aquifers and developing a mathematical model) for contaminant transport affected by oxygen limited biodegradation. Research brief.** Rifai, H.S.; Bedient, P.B.; Wilson, J.T. Oklahoma Univ., Norman, OK (USA). Environmental and Ground Water Inst. Aug 1989. 9p. Available from NTIS, PC A02/MF A01.

See also PB–89-151120.

Many of the organic pollutants entering groundwater are potentially biodegradable in the subsurface. The potential has been demonstrated in aquifers contaminated by wood creosoting process wastes and gasoline. The persistence of many of these organic compounds in the subsurface indicated that some factors must be limiting biodegradation. The research described has been aimed at identifying the major processes that limit biodegradation in aquifers and developing a mathematical model (BIOPLUME) for simulating these processes. In order to identify the rate limiting processes for biodegradation, the equations describing microbial growth and decay and transport of oxygen and contaminants were developed and solved in one and two dimensions. The main purpose of the research was to develop the mathematical tools necessary to describe and simulate the process of oxygen limited biodegradation of organics in groundwater. The model was applied at two sites, the United Creosote Company, Inc. site in Conroe, TX and an aviation gasoline spill site in Traverse City, MI. Field work at the Conroe, TX site indicated that oxygen was limiting the microbial degradation of dissolved hydrocarbons present in the shallow aquifer. At the Traverse City, MI site, model predictions for the rates of mass loss closely matched calculated rates from the field data.

0210 Legislation and Regulations

23504 (NIBR/R–1988:11) **Consequence enquiries of petroleum activity: Experiences based on impressions from US, Canada and Great Britain.** Lerstang, T. Norsk Inst. for By- og Regionsforskning, Oslo (Norway). May 1988. 146p. (In Norwegian). Order Number DE90760286. Available from NTIS (US Sales Only), PC A07/MF A01.

In Norway, the new Petroleum Act of 1985 contains mandatory requirements for Environmental and Social Impact Assessments as part of the public decision making processes. According to the Petroleum Act, it is necessary to assess environmental, economic and social effects, together with risks of pollution, before new areas offshore are opened for petroleum activity. The act also contains the prerequisites of an oil or gas field development or production application. A clause on impact assessment is included. The report is organized in two main parts. One part describes and discusses petroleum related impact assessment with respect to the opening or exploration phases of the offshore activities. The other main part

of the report is based on the impact assessment practice as it relates to development and production plans. A number of items joined with offshore and petroleum related impact assessments in USA, Canada and United Kingdom are considered. 68 refs.

0220 Transport, Handling, and Storage

Refer also to citation(s) 23516

23505 (NIPER–320, pp. 435-450) **Stability and compatibility screening tests for residual fuels.** Anderson, R.P.; Reynolds, J.W. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

Certain problems appear in the utilization of heavy fuels which are thought to be the result of changing feedstocks and processing. These problems include line plugging, strainer plugging, heat exchanger fouling, and viscosity instability. Investigation of the causes of this instability and/or incompatibility involves comparing the chemical compositions of problem fuels with those of non-problem fuels to determine if the differences in composition are accountable for the problem. Testing of residual fuels was extended to another 66 fuels which underwent the baseline stability tests. Utilizing a correlation between Bureau of Mines Correlation Index (BMCI) and toluene equivalence (TE), a simplified test for compatibility of residual fuels was evaluated. Tests on blends with varying amounts of the two components showed the method to have a high degree of prediction accuracy. Plans for field testing of the control protocols have been made. Results are presented.

23506 (NIPER–320, pp. 451-459) **Distillate-fuel-additive chemistry.** Brinkman, D.W.; Stirling, K.Q. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

Diesel fuels prepared by blending straight run middle distillates with light cycle oil from a cracking operation occasionally show effects of degradation by precipitating sediment. To prevent this, various additives are used. Selection of samples with which to test additives has proven difficult. Overprotection of samples during the sampling process decreased the sediment formation so that no differentiation could be made on the effect of the additives. A Texas refinery furnished a reference fuel and an unstable high-sulfur diesel fuel which were blended to provide a sediment-producing fuel. In addition a midcontinent fuel was selected. Specification tests on these and three previously selected fuels showed that all met military specifications. Blending with additives and testing of stability are underway. A test program was devised to study the effect of light cycle oil (LCO) on diesel fuels. In particular, an effort will be made to identify the components of LCO which contribute most to instability. Procedures will include the separation into acids, bases, and neutrals with subsequent analysis of each. A West Coast pair of samples (straight run distillate, LCO) has been selected for the first work, and separations are underway.

23507 (NIPER–320, pp. 461-474) **Storage stability of JP-5.** Brinkman, D.W.; Bhan, O.K. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

This project addresses an option in which additives are used to inhibit fuel degradation. To assist in the investigation, techniques are being developed to monitor the depletion of antioxidants. Techniques were improved for measuring antioxidants in JP-5 fuels and determining compositional changes that occurred in JP-5-type fuels as antioxidants were depleted. Measurements of peroxides and filterable/adherent sediment were completed for fuels (both neat and with additives) after aging up to 60 wk at temperatures of 60, 80 and 90°C. Analyses were made on both adherent sediments and a jelly-like material found in one fuel. Hydrocarbon classes, ketones, and diketones were characterized, and alkyl-1-indanones, $C_nH_{2n-10}O$, was the most abundant type.

23508 (NIPER–320, pp. 475-486) **Thermal stability degradation.** Brinkman, D.W.; Bhan, O.K. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

Specifications JP-5 jet fuel was stressed in a Jet Fuel Thermal oxidation Tester (JFTOT). The stressed and unstressed fuels were separated into acids, bases, and neutrals. A screening test indicated that greater compositional changes occurred in subfractions 5-8 of the acids. Subfraction 5 was primarily hydroxyaromatics by GC/MS analysis. Silylation was used to enhance the results. Alkylphenols were more stable than cycloalkylphenols. Subfraction 7 was found to contain largely carboxylic acids. In the stressed sample, the largest concentration was a $C_{11}H_{14}O_{30}$ (hydroxycarboxylic acid) compound. Sediment analyses established that the sediments formed by thermal stressing of the fuel were primarily aromatic compounds with a significant fraction containing heteroatoms. Dinitrogen compounds gave precipitates on the filter following the heater but not on the heater indicating a slower reaction. Two additional fuels were analyzed. The acid-base-neutral distributions were very similar for stressed and unstressed samples. One of the fuels produced sediments differed from those of the specification fuel in that alkylnaphthalenes and dinitrogen compounds were not found.

23509 (NIPER–320, pp. 505-507) **Weathering effects on fuel quality.** Gurney, M.D.; Wares, R.N. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

In-flight tests of gasoline-type fuels were made to determine problems that could occur as a result of weathering. These tests were conducted at specified temperatures and vapor pressures, at various altitudes, using three aircraft representative of relatively high volume production. Preliminary information supported earlier dynamometer data which indicated that fresh wintergrade autogas in the tanks at 110°F was the worst case for vapor locks. A series of tests to examine the utility of methyl tertiary-butyl ether (MTBE) as a possible cost-effective alternative to aviation gasolines was initiated.

23510 (NIPER–320, pp. 509-511) **Marine diesel fuel criteria.** Gurney, M.D.; Streets, W.L. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

Use of heavy crude feedstocks and residuum processing yield highly aromatic material in the distillate boiling range. Blending this material into diesel fuel reduces cetane number and storage stability. The limits on the quantity and quality of the cracked stock as a diesel fuel blending component have yet to be determined. The research effort is designed to determine the effects of diesel fuel composition on ignition, combustion, and emissions behavior in high-speed marine diesel engines. As the result of a record-setting flood in October 1986, considerable effort was necessary to reestablish the facility for operations. While awaiting recovery, work was done on the performance phase of the high speed diesel engine (HSDE) program and on developing procedures for preparing blends of the fuels. Reconstruction of the HSDE performance test plan called for reruns of the fuels and blending of additional quantities of fuels. The blending and testing of the new fuels was completed and the quantities shipped to Navy facilities. All preparations were completed to start the testing of the blended fuels.

23511 (PB–90-121450/XAB) **Development of nickel-base, corrosion-resistant alloy OCTG (oil country tubular goods).** Ishizawa, Y.; Takaoka, T.; Misao, H.; Masamura, K.; Matsushima, J. Nippon Kokan K.K., Tokyo (Japan). c 1989. 14p. Available from NTIS, PC A07/MF A01).

Included in Nippon Kokan Technical Review, No. 55, 82-89(1989).

Influence of composition of Ni-Cr-Mo alloys on the resistance to SCC and hydrogen embrittlement in sour gas environment was investigated in order to develop a new alloy for oil country tubular

goods (OCTG). SCC resistance in high temperature sour environments with elemental sulfur increased with increasing Mo content and also was improved by a small addition of W, Cu and Nb. Increase in Ni content reduced the resistance to hydrogen embrittlement. Tubulars of 110 ksi grade of which composition was designed based on the experimental studies exhibited excellent properties for sour gas services.

0230 Properties and Composition

Refer also to citation(s) 23461, 23483, 23537, 23538, 23685

23512 (NIPER–320, pp. 249-254) **Understanding the chemistry relating heavy crude feedstock with product slate and quality.** Anderson, R.P.; Wells, J.W. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

Changing requirements for fuels processing that will result from the use of feedstocks from heavy oils, and other alternate fuels including tar sands, shale oil, and coal liquids, will call for new information to enable processes to be changed and new processes to be invented. These feedstocks contain more sulfur, nitrogen, oxygen, and metal compounds than conventional petroleum and usually have a high content of aromatic compounds. Not only is it important to have usable analyses of these types of compounds, but it is also important to be able to estimate how these compounds will respond under various processing conditions. Previous work is summarized. The reports on refinery operations and research needs were further examined and their conclusions confirmed. A report showing how the various approaches at NIPER (thermodynamics, analysis, processing, and product quality) combine to improve the understanding of the chemistry of heavy crudes was completed. Four chapters of the report on Cerro Negro crude oil research were completed. A review of the hydrotreatment of fractions from Mayan crude oil was made utilizing kinetic studies.

23513 (NIPER–320, pp. 255-313) **Development of analytical methodology for analysis of heavy crudes.** Anderson, R.P.; Green, J. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

In characterizing high-boiling petroleum distillates, NIPER has found a preliminary separation into acids, bases and neutrals to be effective. An intensive study of techniques useful in analyzing acids was the principal effort for this year. Significant progress was made in the analysis of pyrrolic benzologs using synchronized scanning fluorescence, determination of total hydroxyl and carboxylic acid content using infrared spectrophotometry combined with chemical derivatization methods, and evaluation of chemical derivatization methods for use in conjunction with gas chromatographic (GC), mass spectrometric (MS), and combined GC/MS analysis of acidic compounds. The merits of determination of individual derivatives using GC/MS were investigated. Improvements in the derivatization procedure made in the course of this work should improve the methods from a quantitative standpoint, since an earlier paper reported that the main limitations of the approach arose from the derivatization reaction itself. An analysis of all isomeric C_0-C_2-phenols in selected fuels and their fractions was undertaken to investigate the capabilities of this approach for quantitative analysis of individual hydroxyaromatics in fossil fuel matrices. Analysis of difunctional acids using high resolution mass spectrometry was applied to fractions from several sources. A set of computer programs was developed to facilitate the handling of the data. The use of nonaqueous titration to measure the weak acids was investigated and an improved technique developed. 54 refs.

23514 (NIPER–320, pp. 315-328) **Thermochemistry and thermophysical properties of organic nitrogen compounds.** Brinkman, D.W.; Steele, W.V. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

The first of a series of reports dealing with the desulfurization and denitrogenation reactions in hydrotreating or hydrocracking was completed. It deals with acyclic and monocyclic compounds. Another report describes the thermodynamic properties of six cyclic nitrogen compounds. This report was abridged for publication in a journal. Group application methods were applied to derive the thermodynamic functions for carbazole from those of N-methylcarbazole. The thermodynamic relations between quinoline and the tetrahydroquinolines (1,2,3,4-tetrahydro-and 5,6,7,8-tetrahydroquinoline) were given in a paper presented at the Calorimetry Conference. Heat capacity and enthalpy studies were completed on 1,2,3,4-tetrahydroquinoline, 7,8-benzoquinoline, and N-methyl-1,2,3,4-tetrahydrocarbazole. Similar studies are underway for 2-methylaniline and indoline which replaced other compounds which could not be made to crystallize. Vapor pressure measurements were performed on 5,6,7,8-etetrahydroquinoline, 7,8-benzoquinoline, N-methylcarbazole, acridine, and 2-methylindole. Densities were determined for quinoline and isoquinoline. Combustion studies were completed on 7,8-benzoquinoline and are in progress on 2-methylindole. Statistical thermodynamic properties of indole and N-methylcarbazole were calculated. Details of these studies are given.

23515 (NIPER–320, pp. 329-338) **Thermochemical and thermophysical properties of organic compounds derived from fossil materials.** Brinkman, D.W.; Chirico, R.D. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

The design of processes to convert alternative crudes (shale oil, heavy crudes, heavy ends, tar sand liquids, and coal liquids) into products that can be used in current technologies without harm to the environment requires thermodynamic data. The development of sufficient thermodynamic data has permitted the examination of the hydrogenation reactions of anthracene and phenanthrene. At low temperatures hydrogenation is favored while at higher temperatures these compounds dehydrogenate. Thus, the 9,10-dihydro compounds are useful as hydrogen donors and the results provide initial thermodynamic rationale for two-stage hydrogenation (hydrogenation at low temperature followed by high-temperature liquefaction). The applicability of group-additivity methods to estimate the thermodynamic properties of cyclic ethers was investigated and found to be useful if sufficient related data is available, but for most systems the necessary values for key compounds has not been developed. The data base for thermodynamic properties of oxygenated compounds was increased by a number of experimental efforts. Heat capacity and enthalpy studies were completed on phthalan, 1,2,3,4-tetrahydroanthracene, 2-ethylbiphenyl, xanthene, 2-methylbiphenyl, 1-naphthol, and 5,6,7,8-tetrahydro-1-naphthol, and are underway on biphenyl and 2-hydroxybiphenyl. Vapor pressure studies were completed on 1,2,3,4-tetrahydroanthracene, phthalan, dibenzofuran, chroman, 1,2,3,4,5,6,7,8-octahydroanthracene, 2-ethylbiphenyl, 1-naphthol, 1,2,3,4-tetrahydrophenanthrene, 2,2′-dimethylbiphenyl, and 4-methylphenanthrene. Enthalpy of combustion studies were completed for xanthene, and 1-naphthol. Statistical thermodynamics was used to calculate the ideal gas thermodynamic properties of 2,3-benzofuran.

23516 (NIPER–320, pp. 389-414) **Determination of the composition and chemistry of heavy crudes, intermediate process streams, products, and by-products.** Brinkman, D.W.; Green, J.B.; Sturm, G.P.; Bhan, O.K. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

The processing of lower-quality fossil fuel feedstock results in a number of problems which are not encountered with conventional petroleum. Some of the problems include instability and incompatibility of fuels, corrosiveness, high energy and hydrogen consumption, and catalyst poisoning. One general way of handling heavy crudes is to hydrogenate the feed before processing. However, the amount of hydrogenation required and the possible need

for other remedies depend on the composition of the crude. Detailed knowledge of the chemistry of the various compound types causing these problems is needed to develop better fuel processing schemes. Various compositional studies were started. The storage stability of hydrotreated Wilmington and Mayan fractions was examined. The distribution of metals and sulfur by molecular weight in various Wilmington and Mayan fractions was obtained. The nickel and vanadium porphyrins in Mayan and Wilmington samples were determined. A general analysis of the condensed liquids from high-severity batch hydrogenation of Wilmington and Mayan residues was made. Work was done to improve mass balances for the separations of residues and hydrotreated products.

23517 (NIPER–320, pp. 415-420) **Thermochemistry of key organic compounds.** Brinkman, D.W.; Steele, W.V. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

Nine compounds were selected as commercial compounds whose thermodynamic properties were needed for development of the knowledge base used to generate methods of estimating thermodynamic values. These compounds were obtained from commercial sources and their purity determined. Three were pure enough for property determination while the other six required purification in the spinning band distillation column. Properties being determined include combustion data, heat capacities, and vapor pressures. These and other properties as needed lead to the determination of the ideal gas standard enthalpy of formation of each compound.

23518 (NIPER–320, pp. 421-429) **Thermodynamics of materials in the Range C_{10}-C_{16}.** Brinkman, D.W.; Steele, W.V. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

The use of heavier crudes as refinery stocks has increased interest in compounds of higher carbon numbers and different compound types over those described in previous evaluations and correlations. To ensure that the optimum slate of substances is obtained by proper selection of conditions such as temperature, pressure, feed, and removal rates for process streams, one needs to be able to predict product yields and reaction equilibria for chemical compounds occurring in fuels in the carbon number range C_{10}-C_{16}. A commercially available data base management program was purchased and code written to facilitate input of the thermodynamic data. The entry of new data from the literature has continued with a special search for vapor pressure data. Common names for many of the compounds have been added to the data base. A report was completed on the identification of data gaps. Computer programs have been transferred for use on the IBM/AT personal computer. Calculations for both the condensed-phase and the ideal gas thermodynamic functions are underway for the compounds for which there are sufficient data available.

23519 (NIPER–320, pp. 487-495) **Characterization of US Navy mobility fuels.** Anderson, R.P.; Woodward, P.W. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

The trend toward processing heavier crudes and using more severe processing causes fuel problems such as solids formation, increased corrosiveness, and increasing viscosity during storage of fuels. To ensure that changes in fuel specifications would not adversely affect the logistics support components, information is needed about equipment in use at fuel depots used by the US Navy. Surveys of fuels and equipment at 25 worldwide US Navy depots were completed. For a survey of commercial marine fuels, 47 samples were obtained worldwide. Commercial automotive/truck diesel fuels were collected worldwide for a total of 42 samples. NIPER has analyzed samples of commercial marine diesel fuels and compared the results with Navy specifications.

23520 (NIPER–320, pp. 497-504) **Fuel composition and ambient temperature effects on aldehyde emissions.** Gurney, M.D.; Seizinger, D.E. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

Exhaust emission studies were made on a fleet of in-use vehicles at 20°, 40°, and 75°F using an aromatic (27%) fuel adjusted to Reid vapor pressures of 14, 12, and 9.9 psi, respectively. The Federal Test Procedure (FTP) was used to obtain the samples which were tested for HC, CO, NO_x, benzene, and formaldehyde. A modified procedure was developed for aldehydes. The dynamometer was operated as a sealed housing for evaporative determination (SHED) using 11 automobiles to determine running losses. A comparative test between the dynamometer SHED and the regulator SHED was run on 3 vehicles. Running loss evaporative emissions proved to be a significant contributor to overall evaporative HC emissions, on the order of 40-45% of the total for most of the vehicles.

23521 (NIPER–320, pp. 513-526) **Diesel fuel composition effects on emissions and performance.** Gurney, M.D.; Clingenpeel, J.M. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

Heavy oils, the first of the alternative feedstocks to be used to supplement supplies of conventional petroleum, present some of the problems which are expected to increase as tar sands, oil shale, and coal liquids are used more extensively. Minimally processed fuels from alternative feedstocks are expected to differ markedly in composition from those produced from traditional light petroleum crudes. The effect of these differences on combustion and exhaust emissions is to a large extent unknown. Knowledge is needed concerning the classes of compounds in heavy-crude products which cause undesirable effects and the concentrations at which they are tolerable. Also, a better understanding of the biological activity exhibited by the particulates from diesel engine exhausts is important. The program of testing was expanded to include a second engine, the Cummins NTC-350, in addition to the Detroit diesel Allison DDA 4-53T. The fuels tested were increased to nine by adding a JP-8 fuel and one spiked with 25 vol % aromatics. Special attention was given to smoke and particulates formed during the combustion process.

23522 (NIPER–320, pp. 527-533) **Fuel trends and analyses.** Anderson, R.P.; Woodward, P.W. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

Annually, five reports describing the quality of petroleum products are prepared by NIPER and distributed internationally. The data are of particular interest in showing trends in fuel quality and are useful in spotting trends which may affect alternate feedstock/fuel development. Reports for surveys on diesel fuels 1986, motor gasoline summer 1986, aviation turbine fuels 1986, motor gasoline winter 1986-87, and heating oils 1987 were completed and distributed. A report on trends in properties of petroleum fuels over the years 1942-1986 was completed. Solicitations for support to continue the program were made.

23523 (NIPER–320, pp. 535-542) **Problem fuels chemistry.** Brinkman, D.W.; Bhan, O.K. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

The incidence of fuels becoming unacceptable between production and utilization is rapidly increasing. The first sectors witnessing the effects of deterioration in the quality of refinery feedstock are the utilities and the military. The utilities are experiencing problems early because of their tendency to procure the heaviest fuels, which are often used as repositories for the parts of the crude that cannot be efficiently upgraded. The military forces are having problems because of their strict specifications and the need for long-term storage capability. More recently the commercial transportation

sector is experiencing difficulties with fuel filter plugging and deposition on engine parts. There are two approaches to methodically solving these problems. The first is to determine in detail the compositional differences in the heavy crudes versus the lighter crudes that are responsible for differences in physical properties. The alternative approach described here is to study the fuels that are causing problems and to determine what components are responsible for the difficulties being encountered. This project addresses problem fuels identified in the military services and applies sophisticated analytical methods to isolate the problem components.

0250 Combustion

Refer also to citation(s) 23521

03 NATURAL GAS

Refer also to citation(s) 23458, 24164

0302 Reserves, Geology, and Exploration

Refer also to citation(s) 23460

23524 (PB–90-146408/XAB) **Development of petrophysical techniques for evaluating tight gas sands. Final technical report, December 1984-November 1988.** ResTech Houston, Inc., TX (USA). Jun 1989. 317p. Available from NTIS, PC A14/MF A02.

Color illustrations reproduced in black and white.

Formation evaluation techniques based on the integration of wireline logging, core analysis, and in situ stress tests have been developed to establish volumetrics, permeabilities, mechanical properties, and closure stresses of potential hydrocarbon bearing reservoirs in the Travis Peak-Hosston formation of northeast Texas and north Louisiana. Objectives of the program included the establishment of a disc stored data base; the quantitative evaluation of all wells in the data base for petrophysical properties utilizing methodologies developed during the study; the identification of zones of high in situ permeability; the development of correlations of gas and water permeability; and the determination of mechanical properties and in situ closure stresses for massive hydraulic fracture design. Results of these efforts have been documented and compare favorably with well tests and core data. They include reliable methods for analyses of porosities and water saturations, predictions of permeabilities from pre-fracture analyses, and determinations of mechanical properties and in situ stress profiles for input into fracture models.

0303 Drilling, Production, and Processing

Refer also to citation(s) 23817, 24163

23525 (NEI-NO–102, pp. 15) **Experience from operation, maintenance and repair of the subsea installation on the north east Frigg field.** Gil, N.S.; Brand, R. Norsk Petroleumsforening, Oslo (Norway). 1987. (CONF-8703333–: Installation and maintenance of subsea production system, Haugesund (Norway), 16-18 Mar 1987). In *Installation and maintenance of subsea production systems, Haugesund (Norway), 16-18 Mar 1987.* Order Number DE90760265. Available from NTIS (US Sales Only), PC A20/MF A01.

After 3 years of operational experience, the unmanned North East Frigg gas field, NEF, has shown to have a safe and reliable production. The gas production has at all times been at a satisfactory level. The paper summarizes the operational experience, inspection, maintenance and repair of the subsea production units with its unmanned Field Control Station. Most of the major shutdowns for shorter periods have been due to failure in the subsea hydraulic system or various Field Control Station shut-downs. The subsea inspection and maintenance program has tha same cyclus as Frigg and is included in the general subsea inspection campaign for the Frigg field. The diving campaign is planned in concurrence with the rest of the field to optimize the use of the diving spread. 4 figs.

23526 (NEI-NO–102, pp. 20) **Development of the Tommeliten fields.** Hatlestad, H. Norsk Petroleumsforening, Oslo (Norway). 1987. (In Norwegian). (CONF-8703333–: Installation and maintenance of subsea production system, Haugesund (Norway), 16-18 Mar 1987). In *Installation and maintenance of subsea production systems, Haugesund (Norway), 16-18 Mar 1987.* Order Number DE90760265. Available from NTIS (US Sales Only), PC A20/MF A01.

The paper deals with the subsea development project for the Tommeliten fields on the Norwegian continental shelf. The various production units are presented and a summary schedule for the project is given. 8 figs.

0305 Health and Safety

Refer also to citation(s) 23894

0306 Economic, Industrial, and Business Aspects

23527 (IGT–90008818) **Institute of Gas Technology annual report for the fiscal year ended August 31, 1989.** Institute of Gas Technology, Chicago, IL (USA). 9 Nov 1989. 28p. Sponsored by Institute of Gas Technology. Available from OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616.

Research and development programs, of the Institute of Gas Technology (IGT), are briefly described. Research was performed in such areas as industrial, commercial, and residential energy utilization; gas distribution and operations; fuel cells and electrochemistry; biotechnology; and fossil fuels. IGT's education program and information service participation is also discussed. (CBS)

0308 Environmental Aspects

Refer also to citation(s) 23377

23528 (PB–90-144577/XAB) **Health assessment for Presque Isle National Priorities List (NPL) Site, Erie, Erie County, Pennsylvania, Region 3. CERCLIS No. PAD980508865. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 4 Aug 1988. 13p. Available from NTIS, PC A03/MF A01.

An abandoned gas well on the Presque Isle peninsula in Lake Erie released black contaminated materials during the 1970s and early 1980s. The well has since been returned to service and is being monitored. There was concern for contaminants on the peninsula and concern that the many gas/oil wells on the mainland might release similar contaminants and affect the area's potable water supply. Analyses of material discharged by the well indicated many organic and inorganic contaminants. Specifically, ammonia, antimony, arsenic, beryllium, cadmium, chromium, lead, chloride, strontium, nickel, selenium, silver, titanium, zinc, benzene and polynuclear aromatic hydrocarbons. Soils at the gas well were subjected to leachate tests (EP Toxicity Tests) that gave a qualitative indication that heavy metals occur in those materials. No definite link was established between the contaminants and gas/oil wells. Based on the available data, there currently is no known human contact with contaminants that were previously discharged from the gas well at Beach Number 7. Therefore, adverse impact on public health from these releases is considered to be unlikely. There are unresolved public health-related issues concerning groundwater at the beach, soils at the gas well, other gas wells on the peninsula, and mainland groundwater.

0330 Properties and Composition

Refer also to citation(s) 23894

0340 Combustion

Refer also to citation(s) 23436, 23718, 24361, 24362

23529 (NEI-DK–267) **Chimneys attached to small gas boilers.** Rachlitz, C.-O. Teknologisk Inst., Taastrup (Denmark). Afd. for Varme-og Installationsteknik. Apr 1987. 55p. (In Danish). Order

Number DE90760216. Available from NTIS (US Sales Only), PC A04/MF A01.

The aim of the compendium's author was to provide a basis for the evaluation of chimneys, especially in relation to natural gas boilers utilized for heating purposes in houses. The emphasis is on installations with a 120kW capacity. It is pointed out that the most significant problem in relation to chimneys attached to gas-fired boilers is vapor condensation and thus the choice of building materials and the dimensioning of the chimney are very important. These problems are dealt with and suggestions for solving them are presented. The text is illustrated by diagrams and graphs. (AB).

23530 (NEI-DK–289) **Modeling of chemical reaction: Status report: Kinetic reaction database, the chemical kinetic model.** Glarborg, P. (Laboratoriet for Varme- og Klimateknik, Danmarks Tekniske Hoejskole (Denmark)); Hadvig, S. Nordisk Gasteknisk Center, Hoersholm (Denmark). Jul 1989. 66p. (In Danish). Order Number DE90760252. Available from NTIS (US Sales Only), PC A04/MF A01.

This status report describes the ongoing efforts to develope a reliable chemical kinetic model for combustion of natural gas, including formation and destruction of pollutants such as NOx. The project is part of the NGC-project Modelling of Chemically Reactive Turbulent Flow. This part of the project contains the following phases: (1) collection of a chemical kinetic database for combustion of natural gas, (2) development of a chemical kinetic model, using the data base, and (3) verification and revision of model and submechanisms through test against selected experimental data. The scope and the format of the data base is discussed, and a preliminary version of the database is listed in appendix A. A status is made for the chemical kinetic model and examples of comparison between predicitions and experimental data are shown. A preliminary recommended reaction mechanism describing the nitrogen chemistry in natural gas combustion that can be used to simulate e.g. reburning is shown in appendix B. Parts of the kinetic model that require further research are identified. (author).

04 OIL SHALES AND TAR SANDS

0403 Drilling, Fracturing, and Mining

23531 (DOE/MC/11076–2767) **Oil shale mining studies and analyses of some potential unconventional uses for oil shale.** McCarthy, H.E.; Clayson, R.L. Western Research Inst., Laramie, WY (USA); Synfuels Engineering and Development, Inc., Rifle, CO (USA). Jul 1989. 61p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-86MC11076. Order Number DE90000417. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Engineering studies and literature review performed under this contract have resulted in improved understanding of oil shale mining costs, spent shale disposal costs, and potential unconventional uses for oil shale. Topics discussed include: costs of conventional mining of oil shale; a mining scenario in which a minimal-scale mine, consistent with a niche market industry, was incorporated into a mine design; a discussion on the benefits of mine opening on an accelerated schedule and quantified through discounted cash flow return on investment (DCFROI) modelling; an estimate of the costs of disposal of spent shale underground and on the surface; tabulation of potential increases in resource recovery in conjunction with underground spent shale disposal; the potential uses of oil shale as a sulfur absorbent in electric power generation; the possible use of spent shale as a soil stabilizer for road bases, quantified and evaluated for potential economic impact upon representative oil shale projects; and the feasibility of co-production of electricity and the effect of project-owned and utility-owned power generation facilities were evaluated. 24 refs., 5 figs., 19 tabs.

0404 Oil Production, Recovery, and Refining

Refer also to citation(s) 23420, 23463, 23464, 23465

23532 (AOSTRA–8844) **Preliminary evaluation of a regional secondary upgrader and sattelite mining/AOSTRA [Alberta Oil Sands Technology and Research Authority] Taciuk process production facilities.** Padamsey, R.; Farries, M.; Ritcey, R. Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada). Jun 1989. 52p. (MICROLOG–90-00372). Available from PC Alberta Oil Sands Technology and Research Authority, 500 Highfield Pl., 10010-106 St., Edmonton, AB, CAN T5J 3L8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This study was undertaken to evaluate the application of the AOSTRA (Alberta Oil Sands Technology and Research Authority) Taciuk Process (ATP) to the concept of regional upgrader. An alernative project employing satellite mining plus ATP production facilities and a regional secondary upgrader was developed and evaluated (ATP case); this report outlines the methodology use in developing and evaluating the ATP case and summarizes the economic results. Both cases were designed for the production of 30,000 bbl/calendar day of bitumen. The evaluation is based on the premise that the ATP distillates are suitable for hydrotreating directly in a regional secondary upgrader to synthetic crude oil (SCO). The design basis and economic analysis of the regional secondary upgrader, of the satellite surface mining/ATP production facilities, and of the necessary pipelines are presented. The global supply cost per barrel of SCO is found to be Canadian $28.20, versus Canadian $33.33 for the base case, on an advantage of the order of Canadian $5/bbl; however, it is AOSTRA's opinion that the accuracy of the estimates is + or - 25%. Two appended documents summarize the development of the ATP. The Taciuk processor is a single, horizontal, rotating vessel which processes oil sands to extract the bitumen and to produce a partially upgraded oil. The main feature of the Taciuk processor is its ability to recover more produce from a wide range of oil sands when compared to existing commercial technologies. The spent sand produced is clean and environmentally acceptable for disposal as landfill or for return to the mine pit. The economic comparisons with the existing hot water processes favor the Taciuk process. 8 figs., 17 tabs.

23533 (DOE/MC/11076–2757) **Quenched nonisothermal pyrolysis of Asphalt Ridge tar sand and Boscan heavy oil mixtures.** Turner, T.F.; Glaser, R.R.; Thomas, B.E. Western Research Inst., Laramie, WY (USA). Aug 1989. 35p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-86MC11076. Order Number DE90000409. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Quenched nonisothermal experiments were performed on Asphalt Ridge tar sand and on mixtures of tar sand and Boscan oil at two heating rates. Reactions were quenched at temperatures in the range of 200– 600°C (392–1112°F) and the nonvolatile organic products were sequentially extracted with n-heptane, toluene, and pyridine. Coke contents were determined by combustion. Kinetic analyses of the coversion of Asphalt Ridge tar sand and Boscan coprocessing mixtures show remarkable similarities. A kinetic fit to data from both Asphalt Ridge and Boscan oil coprocessing tests was performed with the result being a good fit to all the data. The shapes of the soluble, nonvolatile product concentrations indicate a series reaction scheme leading to the formation of coke and pyridine-soluble material. For the Asphalt Ridge tar sand, both heptane and toluene solubles decompose to form pyridine solubles and coke. For the Boscan oil/tar sand mixtures, heptane solubles form toluene solubles which form pyridine solubles and coke. 6 refs., 19 figs., 9 tabs.

23534 (DOE/MC/11076–2762) **A sensitivity study of the effect of tar sand and oil-phase properties on the wet forward combustion of the asphalt ridge resource.** Vaughn, P. Western Research Inst., Laramie, WY (USA). Oct 1988. 80p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-86MC11076. Order Number DE90000416. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The Tar Sand Reservoir Simulator (TSRS) is used to numerically evaluate the sensitivity of thermal recovery performance to physical properties of fluids and tar sand. The sensitivity of these properties is determined by comparing the results of a series of simulations to a realistic base simulation. The thermal process considered for this study is the wet forward combustion of Asphalt Ridge tar sand in

an adiabatic tube reactor. The physical properties evaluated include oil-phase viscosity, oil-component volatility, relative permeability, absolute permeability, tar sand porosity, and tar sand thermal conductivity. The results of this study indicate that the most sensitive fluid properties are oil-phase viscosity and relative permeability to gas. Absolute tar sand permeability and porosity also have a significant effect on recovery performance. Of the thermal recovery performance parameters evaluated, injection pressure and fuel composition are the most responsive. Total oil yield is relatively insensitive to the changes in properties investigated in this study. 10 refs., 23 figs., 14 tabs.

23535 (DOE/MC/11076–2765) **Numerical simulation of the wet forward combustion of California tar sand in a tube reactor.** Vaughn, P. Western Research Inst., Laramie, WY (USA). Oct 1988. 39p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-86MC11076. Order Number DE90000420. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Tar Sand Reservoir Simulator (TSRS) is used to model the wet forward combustion of California tar sand from the Arroyo Grande deposit. The model's options and input data are selected to numerically duplicate the recent set of experiments conducted at Western Research Institute (WRI) in which the California tar sand was processed in a one-dimensional tube reactor. The experiments and their numerical simulation counterparts are conducted to evaluate the wet forward combustion process for the California tar sand and to evaluate the effects of differing injection gas steam-to-oxygen ratios on recovery performance. Simulation results indicate that the combustion front can be successfully propagated through the Arroyo Grande deposit. The injection pressure required to maintain flow is significantly lower for the processing of Arroyo Grande tar sand than for the processing of Asphalt Ridge or Sunnyside tar sand. The numerical simulations show the same general trends of reduced fuel deposition, increased oil yield, increased frontal velocity, and decreased temperature with increasing steam-to-oxygen ratio as were observed in the experimental tests conducted on both the Arroyo Grande and Asphalt Ridge tar sands. 15 refs., 4 figs., 5 tabs.

0405 Properties and Composition

Refer also to citation(s) 23514, 23515, 23533

23536 (CONF-850710–, pp. 683-695) **Prediction of viscosity of bitumen/gas systems by the extended principle of corresponding states.** Johnson, S.E. (Univ. of Calgary, Alberta (Canada)); Svrcek, W.Y.; Mehrotra, A.K. United Nations Development Programme, New York, NY (USA). UNITAR/UNDP Information Centre; Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada); Petroleos de Venezuela, S.A., Caracas (Venezuela); USDOE, Washington, DC (USA). Jul 1988. From 3. UNITAR/UNDP international conference on heavy crude and tar sands; Long Beach, CA (USA); 22-31 Jul 1985. In *The third UNITAR/UNDP [United Nations Institute for Training and Research/United Nations Development Program] international conference on heavy crude and tar sands.* Order Number DE90005488. Available from NTIS, PC A99/MF A01.

Athabasca bitumen is characterized as a mixture of pseudo components. The Kesler-Lee equations are used to estimate the critical properties and acentric factor of each fraction, and the critical volume was calculated by the method of Riedel. Using methane as the reference fluid and paraffinic shape factors, the viscosity predictions from the extended corresponding states method were completely inadequate. To improve the viscosity predictions, four reference fluids of aromatic-naphthenic nature were screened. Out of these reference fluids, PSU #625 (in API Research Project 42) gave the best viscosity predictions with an average absolute deviation of 6% from experimental data. The prediction of CO_2-saturated bitumen viscosity was accomplished by extending the state of the reference fluid to the dilute and dense gas phase regions. For comparison, the Teja-Rice method was also used to predict the gas-saturated bitumen viscosity. The predictions were found to be satisfactory, with an average absolute deviation of 19% from experimental data.

23537 **Geoporphyrin structure determination using chemical ionization-mass spectrometry/mass spectrometry.** Van Berkel, G.J. (Oak Ridge National Laboratory, TN (USA)); Glish, G.L.; McLuckey, S.A. *Organic Geochemistry (UK),* 14(2): 203-212 (1989). DOE Contract AC05-84OR21400.

The utility of NH_3 chemical ionization-mass spectrometry (NH_3 CI-MS) for determining the pyrrole sequence of porphyrins is reviewed. Mass spectrometry/mass spectrometry [metastable ion spectra and high energy (5 keV) collision induced dissociation (CID) spectra] is used to obtain structurally significant spectra of the individual ions in the NH_3 CI mass spectra of porphyrins. The MS/MS spectra of the monopyrrolic fragment ions are shown to be of use in determining the structure of the substituent groups on the pyrroles. MS/MS spectra of the protonated porphyrinogen, formed via a reduction of the porphyrin in the ion source of the mass spectrometer, supplies the same structural information as the CI mass spectrum. Thus, pyrrole sequencing of porphyrins within simple mixtures or analyzing samples containing chemical noise that obscures the pyrrolic ion region of the spectrum is possible. Porphyrin structural analysis using NH_3 CI-MS/MS/MS is discussed.

23538 **Supercritical fluid chromatography-mass spectrometry: A potentially useful technique for porphyrin analysis.** Wright, B.W. (Pacific Northwest Laboratory, Richland, WA (USA)); Smith, R.D. *Organic Geochemistry (UK),* 14(2): 227-232 (1989). DOE Contract AC06-76RL01830.

Supercritical fluid chromatography-mass spectrometry (SFC-MS) and related analytical techniques offer the potential of making significant contributions to the analysis and characterization of geoporphyrins in complex matrices. The combination of a chromatographic separation method with mass spectrometric detection provides a powerful tool as evidenced by the dominance of gas chromatography-mass spectrometry (GC-MS) for the characterization of amenable compounds. The favorable physical properties and high solvating powers of supercritical fluids allow separation of less-volatile and higher-molecular-weight compounds generally restricted to liquid chromatography with separation efficiency per unit time and chromatographic resolution approaching that of gas chromatography. Furthermore, mild operating temperatures (determined by the choice of mobile phase) allow application to thermally labile compounds that cannot generally be addressed by GC. The potential advantages of SFC-MS for porphyrin analysis and the results from preliminary porphyrin analyses are described in this paper.

0406 Products and By-Products

Refer also to citation(s) 23451

0408 Economic, Industrial, and Business Aspects

Refer also to citation(s) 23531

05 NUCLEAR FUELS

0505 Uranium Enrichment

Refer also to citation(s) 23987

0507 Fuels Production and Properties

Refer also to citation(s) 23759, 23760, 23761, 23762, 23763, 23764, 23765, 23768, 24034

23539 (IWGFPT–27, pp. 183-196) **Diffusion and behaviour of iodine and rubidium in UO_2 and ThO_2.** Matzke, H. (Commission of the European Communities, Karlsruhe (Germany, F.R.). European Inst. for Transuranium Elements); Ray, I.L.F.; Verral, R.A. International Atomic Energy Agency, Vienna (Austria). International Working Group on Water Reactor Fuel Performance and Technology. Sep 1987. (CONF-8611109–: IAEA technical committee meeting on water reactor fuel behaviour and fission products release in off-normal and accident conditions, Vienna (Austria), 10-13 Nov 1986). In *Water reactor fuel behaviour and fission products release in off-normal and accident conditions: Proceedings of a technical committee meeting held in Vienna, 10-13 November*

1986. Order Number DE90621928. Available from NTIS (US Sales Only), PC A12/MF A01; OSTI; INIS.

The actinide oxides of the fluorite structure, UO_2 and $(U,Pu)O_2$ are used as fuels in nuclear reactors. ThO_2 and mixed oxides $(U,Th)O_2$ are considered as fuels for the future. During operation, fission creates volatile fission products: Te, Br, I, Rb, Cs and Kr, Xe. Whereas much information is available on the diffusion and the behaviour of the rare gases, relatively little is known for the other volatile elements. The defect structure of the oxides is well understood, based on a large number of measurements of self-diffusion and on theoretical calculations. The existing knowledge is reviewed as basis for understanding measurements of iodine and rubidium behaviour. Radioactive tracers were used for diffusion (and release) measurements of Rb and I, and transmission electron microscopy was employed to investigate larger defects, precipitation of I and Rb and their behaviour as function of temperature (room temperature to 1800 deg. C). At concentrations of the level of 1 at. %, both elements form precipitates (or bubbles at elevated temperatures). This affects and changes the diffusional behaviour. Only at low concentrations, unperturbed volume diffusion is observed, which can be related to self-diffusion of the less mobile species, i.e. the metal ions. The relevant diffusion mechanisms, interaction of the impurities with defects and implications for fuel operation are discussed. (author). 26 refs, 10 figs, 3 tabs.

0508 Spent Fuels Reprocessing

Refer also to citation(s) 23560

23540 (ZfK–655) **A facility for recovery of uranium from the waste solutions of fission molybdenum production - AMOR II.** Hladik, O.; Boessert, W.; Bernhard, G.; Grahnert, T. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1988. 62p. (In German). Order Number DE90621386. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

A facility is described for the recovery of the enriched uranium from the waste solutions of the fission molybdenum production. To tackle this task a solvent extraction process for the separation of uranium from fission products by tri-n-butylphosphate, diluted in tetrachloro-ethen has been developed. Owing to the special composition of the feed solution and the technical conditions the well-known PUREX-process had to be modified. The extraction and reextraction of uranium is carried out by a new mixer-settler unit which works without mechanical moving parts. The whole facility including the immediate storage tanks is installed in four semi-hot cells, shielded with 24 cm steel stones. The needed plant throughput has been assumed as 5 kg U (35% enriched) per year. It will be able to process this amount in 10-12 weeks (process time: 7 h/day). The facility was put into operation in 1985. The content of nuclear material is regularly being examined by the International Atomic Energy Agency according to the non-proliferation agreement. (author).

0509 Transport, Handling, and Storage

Refer also to citation(s) 23559, 23561, 23629, 23744, 23745, 23746, 23748, 24145

23541 (PNL-SA–17727) **Experience with failed or damaged spent fuel and its impacts on handling.** Bailey, W.J. Pacific Northwest Lab., Richland, WA (USA). Dec 1989. 8p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC06-76RL01830. (CONF-900161–5: 7. Institute of Nuclear Materials Management spent fuel management seminar, Washington, DC (USA), 17-19 Jan 1990). Order Number DE90008614. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Spent fuel management planning needs to include consideration of failed or damaged spent light-water reactor (LWR) fuel. Described in this paper, which was prepared under the Commercial Spent Fuel Management (CSFM) Program that is sponsored by the US Department of Energy (DOE), are the following: the importance of fuel integrity and the behavior of failed fuel, the quantity and burnup of failed or damaged fuel in storage, types of defects, difficulties in evaluating data on failed or damaged fuel, experience with wet storage, experience with dry storage, handling of failed or damaged fuel, transporting of fuel, experience with higher burnup fuel, and conclusions. 15 refs.

23542 (SAND–89-0018, pp. 11-20) **Overview of effects of burnup credit on cask design.** Allen, G.C. Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

A number of opportunities exist to increase the productivity of the next generation of spent fuel shipping casks. One of the opportunities being evaluated by Sandia National Laboratories (SNL) under the sponsorship of the US DOE Cask System Development Program (CSDP) at Idaho National Engineering Laboratory (INEL) is the implementation of burnup credit in the design of spent fuel casks. Burnup credit is defined as accounting for the effects of fuel burnup in the criticality safety analysis of a cask. Burnup refers to the fissile nuclide reduction and the fission and activation product buildup that result in reduced reactivity of fuel after it has been used for producing power in a nuclear reactor. An important step in implementing burnup credit is to establish an understanding of how burnup credit affects cask design. The purpose of this paper is to provide an overview of the effects of burnup credit on spent fuel cask design. This will be accomplished by addressing the following: what functions of a cask; how does burnup credit potentially affect a cask; how does burnup credit affect basket design; and what design or functional requirements are likely to be affected by burnup credit.

23543 (SAND–89-0018, pp. 21-43) **Parametric neutronic analyses related to burnup credit cask design.** Parks, C.V. (Oak Ridge National Lab., TN (USA)). Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

The consideration of spent fuel histories (burnup credit) in the design of spent fuel shipping casks will result in cost savings and public risk benefits in the overall fuel transportation system. The purpose of this paper is to describe the depletion and criticality analyses performed in conjunction with and supplemental to the referenced analysis. Specifically, the objectives are to indicate trends in spent fuel isotopic composition with burnup and decay time; provide spent fuel pin lattice values as a function of burnup, decay time, and initial enrichment; demonstrate the variation of k_{eff} for infinite arrays of spent fuel assemblies separated by generic cask basket designs (borated and unborated) of varying thicknesses; and verify the potential cask reactivity margin available with burnup credit via analysis with generic cask models.

23544 (SAND–89-0018, pp. 45-53) **Effects of burnup credit on cask basket design spacing requirements.** Westfall, R.M. (Oak Ridge National Lab., TN (USA)). Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

Four safety functions-containment, shielding, criticality control, and heat transfer-have been discussed in the context of how burnup credit affects shipping cask design constraints. Since the cask basket is the primary criticality control mechanism, the effect of burnup credit upon basket design is of prime importance. The opportunity to increase cask capacity by reducing the design spacing of the cask basket is the motivation for applying burnup credit. The purpose of this paper is to describe the analytical model applied in establishing cask capacities and to summarize the findings with regard to capacity increases due to burnup credit.

23545 (SAND–89-0018, pp. 55-59) **A survey of previous and current industry-wide efforts regarding burnup credit.** Jones,

R.H. Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

Sandia has examined the matter of burnup credit from the perspective of physics, logistics, risk, and economics. A limited survey of the nuclear industry has been conducted to get a feeling for the actual application of burnup credit. Based on this survey, it can be concluded that the suppliers of spent fuel storage and transport casks are in general agreement that burnup credit offers the potential for improvements in cask efficiency without increasing the risk of accidental criticality. The actual improvement is design-specific but limited applications have demonstrated that capacity increases in the neighborhood of 20 percent are not unrealistic. A number of these vendors acknowledge that burnup credit has not been reduced to practice in cask applications and suggest that operational considerations may be more important to regulatory acceptance than to the physics. Nevertheless, the importance of burnup credit to the nuclear industry as a cask design and analysis tool has been confirmed by this survey.

23546 (SAND–89-0018, pp. 61-64) **Burnup credit effect on proposed cask payloads.** Hall, I.K. (EG and G Idaho, Inc., Idaho Falls, ID (USA)). Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

The purpose of the Cask Systems Development Program (CSDP) is to develop a variety of cask systems which will allow safe and economical movement of commercial spent nuclear fuel and high-level waste from the generator to the Federal repository or Monitored Retrievable Storage (MRS) facility. Program schedule objectives for the initial phase of the CSDP include the development of certified spent fuel cask systems by 1995 to support Office of Civilian Radioactive Waste Management shipments from the utilities beginning in the late 1990s. Forty-nine proposals for developing a family of spent fuel casks were received and comparisons made. General conclusions that can be drawn from the comparisons are that (1) the new generation of casks will have substantially increased payloads in comparison to current casks, and (2) an even greater payload increase may be achievable with burnup credit. The ranges in the payload estimates do not allow a precise separation of the payload increase attributable to the proposed allowance of fuel burnup credit, as compared wilt the no-burnup-credit case. The beneficial effects of cask payload increases on overall costs and risks of transporting spent fuel are significant; therefore further work aimed toward taking advantage of burnup credit is warranted.

23547 (SAND–89-0018, pp. 65-90) **Evaluation of burnup credit for dry storage casks.** Wakeman, B.H. (Virginia Power Co., Richmond (USA)); Ahmed, S.A.; Smith, M.L. Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

The key component in determining the capacity of a spent fuel storage cask is the fuel basket. Even minor changes in the cask body design are limited by the basket design. The basket design determines the fuel loading arrangement and the capacity of the cask. Optimization of a fuel basket design for higher capacity must first ensure that the following functional criteria have been met: the cask must remain subcritical when loaded with the fuel to be stored; the cask must be capable of dissipating the decay heat produced in the fuel, without deformation; and the cask must provide adequate structural integrity for stored fuel under normal or accidental conditions. This paper provides an evaluation of burnup credit in the areas of engineering design of cask baskets; criticality, structural, shielding, and thermal adequacy of burnup credit casks; utility operational controls; and economics.

23548 (SAND–89-0018, pp. 91-107) **Burnup credit in a dry storage module.** Thornton, J.R. (Duke Power Co., Charlotte, NC (USA)). Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

Comparison of spent fuel storage expansion options available to Oconee Nuclear Station revealed that dry storage could be economically competitive with transshipment and rod consolidation. Economic competitiveness, however, mandated large unit capacity while existing cask handling facilities at Oconee severely limited size and weight. The dry storage concept determined to best satisfy these conflicting criteria is a 24 pressurized water reactor (PWR) fuel assembly capacity NUTECH Horizontal Modular Storage (NUHOMS) system. The Oconee version of the NUHOMS system takes advantage of burnup credit in demonstrating criticality safety. The burnup credit criticality analysis was performed by Duke Power Company's Design Engineering Department. This paper was prepared to summarize the criticality control design features employed in the Oconee NUHOMS-24P DSC basket and to describe the incentives for pursuing a burnup credit design. Principal criticality design parameters, criteria, and analysis methodology are also presented.

23549 (SAND–89-0018, pp. 109-123) **Analysis of collective life-cycle dose for burnup credit shipping casks.** Brentlinger, L.A. (Battelle Labs., Columbus, OH (USA)); Peterson, R.W.; Hofmann, P.L. Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

In 1987, several studies were conducted by Sandia National Laboratories (SNL) to investigate the feasibility of and the incentive to justify the consideration of spent fuel histories in the design of spent fuel shipping casks. Taking credit for reduction in fissile content of fuel elements resulting from burnup credit is not current practice in the design and certification of shipping casks. The general argument can be made, however, that if this were done cask capacities could be increased over the current shipping cask designs which do not take the benefit of such burnup credit. This paper deals specifically with the question of occupational and public dose reduction via the use of a series of postulated burnup-credit cask designs.

23550 (SAND–89-0018, pp. 125-134) **Burnup credit in nuclear waste transport: An economic analysis.** Dippold, D.G. (Battelle Memorial Institute, Columbus, OH (USA)). Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

The US DOE is responsible for transporting nuclear spent fuel from commercial reactors to monitored retrievable storage (MRS) facilities and/or to repositories. Current plans call for approximately 110,000 metric tons uranium (MTU) to be transported over approximately 40 years beginning in 1998. Because of the large volume of spent fuel to be transported, new generations of spent fuel transportation casks are being planned. These casks will embody the latest technology and will be designated to accommodate the spent fuel in a way that maximizes the overall efficiency of the cask. In planning for the new generation of transport casks, the DOE is investigating the possibility of tailoring the cask design for the extent to which spent fuel has been used in the reactors, or, for spent fuel burnup. Granting design credit for burnup would allow one to fabricate casks with relatively larger capacities than would be possible otherwise. The remainder of the paper discusses the economic implications of using burnup credit in cask design, discusses the

approach used in analyzing the economics of burnup credit, describes the results of the analysis, and offers some conclusions about the economic value of the burnup credit option.

23551 (SAND–89-0018, pp. 155-156) **An overview of burnup credit safety issues.** Fischer, L.E. (Lawrence Livermore National Lab., CA (USA)). Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

The technical basis for establishing acceptance criteria for the application of spent fuel burnup credit to dry cask storage installations is being developed by Lawrence Livermore National Laboratory for the Nuclear Regulatory Commission. The development of the criteria involves two phases: the first is the feasibility assessment and the second is the development of procedures and acceptance criteria. In the feasibility phase, all safety-related technical issues are identified and evaluated to assess burnup credit with adequate safety margins preserved. In phase two, the NRC policy on burnup credit is established with appropriate safety margins, quality controls, quality assurance, and administrative controls specified.

23552 (SAND–89-0018, pp. 157-161) **Summary - criticality analysis review methods for independent spent fuel storage installations.** Lloyd, W.R. (Lawrence Livermore National Lab., CA (USA)). Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

The objective of this paper is to present several burnup credit calculations using the KENO V.a code and the 123GROUPMTH cross section set in Standardized Computer Analysis for Licensing Evaluation (SCALE) for a spent fuel storage cask in an independent spent fuel storage installation. The completion of some broad tasks needed to allow burnup credit are presented that include development of acceptable methodology, development of procedures for performing the methodology, and verification that the methodology is correct. Before burnup credit, evaluation methodology with fresh fuel is considered. k_{eff} must include results for the cask and the bias for the computational tool when compared to critical experiments similar to conditions in the cask. k_{eff} results are given for several critical experiments for low enriched (<6 without) U and UO_2 fuel rods in water using the KENO V.a code and the 27GROUPNDF4 cross section set and using the computational tool above. What follows is a method for applying a bias from critical experiment evaluations to a cask k_{eff} calculation to determine the upper limit k_{eff} at 95% confidence.

23553 (SAND–89-0018, pp. 189-196) **An approach for verifying analysis techniques applicable to the burnup credit technical issue.** Parks, C.V. (Oak Ridge National Lab., TN (USA)). Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

To date, the approach used for the development and certification of spent fuel storage and transport casks has been based on an assumption of fresh fuel isotopics in the criticality safety analysis. From a physics viewpoint, there is a considerable reactivity reduction when the isotopics representative of the depleted (or burned) fuel are used in a criticality analysis. Thus, by taking credit for the burned state of the fuel (i.e., burnup credit), a cask designer can achieve a significant increase in payload. A recently analysis has established the potential advantages of pursuing acceptance of burnup credit in the design of new generation casks. However, it must be demonstrated that appropriate procedures and techniques are available to ensure that the level of safety in current cask design is not compromised. As part of this objective, a joint Department of Energy (DOE) Electric Power Research Institute (EPRI) project is underway to: (1) demonstrate that calculational tools and cross-section data are available to adequately predict k_{eff} using spent fuel isotopics, and (2) quantify the uncertainty in the calculated k_{eff} values due to isotopic variations (a) predicted by established depletion models, and (b) caused by spatial burnup variations.

23554 (SAND–89-0018, pp. 227-235) **Nuclear fuel accountability experience.** Snow, C.T. (Virginia Power Co., Richmond (USA)). Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

The use of burnup credit for dry storage nuclear fuel casks requires that the reactivity of the fuel assemblies be properly verified. As an operating nuclear utility, Virginia Power Company has extensive experience in the administrative control of fuel assemblies from the time they arrive on-site until the time they are dispositioned for final storage, whether in pool storage, dry cask storage, or off-site shipment. The initial uranium enrichment is verified before the assembly arrives on-site, and analyses determine the burnup and the uranium and plutonium content of the assembly during its operation. Assemblies that may have experienced fuel cladding defects, as indicated by reactor coolant system radionuclide measurements, are examined following the fuel cycle and placed on a restricted list of fuel assemblies which are not to be reused in a reactor.

23555 (SAND–89-0018, pp. 237-247) **Verification of criticality safety in on-site spent fuel storage systems.** Rasmussen, R.W. (Duke Power Co., Charlotte, NC (USA)). Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

On February 15, 1984, Duke Power Company received approval for a two-region, burnup credit, spent fuel storage rack design at both Units 1 and 2 of the McGuire Nuclear Station. Duke also hopes to obtain approval by January of 1990 for a dry spent fuel storage system at the Oconee Nuclear Station, which will incorporate the use of burnup credit in the criticality analysis governing the design of the individual storage units. While experiences in burnup verification for criticality safety for their dry storage system at Oconee are in the future, the methods proposed for burnup verification will be similar to those currently used at the McGuire Nuclear Station in the two-region storage racks installed in both pools. In conclusion, the primary benefit of the McGuire rerack effort has obviously been the amount of storage expansion it provided. A total increase of about 2,000 storage cells was realized, 1,000 of which were the result of pursuing the two-region rather than the conventional poison rack design. Less impacting, but equally as important, however, has been the experience gained during the planning, installation, and operation of these storage racks. This experience should prove useful for future rerack efforts likely to occur at Duke's Catawba Nuclear Station as well as for the current dry storage effort underway for the Oconee Nuclear Station.

23556 (SAND–89-0018, pp. 285-301) **Development of portable subcriticality measurement system for spent fuel shipping and storage casks.** Mihalczo, J.T. (Oak Ridge National Lab., TN (USA)). Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

The Cf-252 source-driven neutron noise analysis method could be used to measure subcriticality of storage casks of burned light water reactor (LWR) fuel, with and without boron in the water, when they are fully loaded, or as they are being loaded. Measurements of k_{eff} would provide the parameter most directly related to the criticality safety of storage cask configurations of LWR fuel and could allow proper credit for fuel burnup without reliance on calculations. Allowance for burnup, in turn, could lead to more

cost-effective cask designs. The experiments could also be used to benchmark calculational methods for spent fuel. The steps in the development of this experimental method include: demonstrating the capability of the Cf-252 source-driven noise analysis procedure to accurately measure the subcriticality of spent LWQR fuel in a storage cask flooded with water, to developing a portable measuring system, and demonstrating that systems adequacy. This method has already been used at a critical experiments facility on arrays of pressurized water reactor (PWR) fuel pins typical of the size of storage cask configurations. These experiments demonstrated the feasibility of developing neutron detectors that can function in spent fuel cask environments and of constructing ionization chambers containing Cf-252 of adequate intensity for these measurements. This paper describes the method, summarizes its status, reviews past experiments and measurement systems, describes measurements on unirradiated PWR fuel pins, discusses proposed demonstration experiments, examines the potential for a portable measurement system, and presents some conclusions.

23557 (SAND–89-0018, pp. 303-314) **Detailed description of the measurement methodology.** Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

The Cf-252 source-driven neutron noise analysis method obtains the subcriticality state from the signals from three detectors: the first, a parallel plate ionization chamber with Cf-252 electroplated on one plate. Every spontaneous fission produces an electrical pulse that serves as a time source of fission neutrons; the second and third detectors contain fissile material. These are placed in or near the system and detect particles from the fission chain multiplication process. The Cf-252 chamber is also located in or near the system to be measured. The methodology evolved time domain from measurements. Two types of time domain measurements were performed, pulsed neutron and Rossi-α. These measurements were performed for a variety of systems including uranium metal (highly enriched, ~93 wt% U-235). The use of a californium neutron source as a timed source of fission neutrons for uranium and plutonium metal systems simplifies the ability to perform pulsed neutron measurements because pulsed neutron source is relatively easy to fabricate. The two types of measurements were performed in the time domain and then measurements were performed in the frequency domain for comparison.

23558 (SAND–89-0018, pp. 315-335) **A relative risk comparison of criticality control strategies based on fresh fuel and burnup credit design bases.** Sanders, T.L. Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

The fresh fuel design basis provides some margin of safety, i.e., criticality safety is almost independent of loading operations if fuel designs do not change significantly over the next 40 years. However, the design basis enrichment for future nuclear fuel will most likely vary with time. As a result, it cannot be guaranteed that the perceived passivity of the concept will be maintained over the life cycle of a future cask system. Several options are available to ensure that the reliability of a burnup credit system is comparable to or greater than that of a system based on a fresh fuel assumption. Criticality safety and control reliability could increase with burnup credit implementation. The safety of a burnup credit system could be comparable to that for a system based on the fresh fuel assumption. A burnup credit philosophy could be implemented without any cost-benefit tradeoff. A burnup credit design basis could result in a significant reduction in total system risk as well as economic benefits. These reductions occur primarily as a result of increased cask capacities and, thus, fewer shipments. Fewer shipments also result in fewer operations over the useful life of a cask, and opportunities for error decrease. The system concept can be designed such that only benefits occur. These benefits could include enhanced criticality safety and the overall reliability of cask operations, as well as system risk and economic benefits. Thus, burnup credit should be available as an alternative for the criticality design of spent fuel shipping casks.

0510 Economic, Industrial, and Business Aspects

Refer also to citation(s) 23545, 23546, 23551, 23552

23559 (SAND–89-0018, pp. 135-146) **A CASKCOM: A cask life cycle cost model.** Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington. DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

CASKCOM (cask cost model) is a computerized model which calculates the life cycle costs (LCC) associated with specific transportation cask designs and discounts those costs, if the user so chooses, to a net present value. The model has been used to help analyze and compare the life cycle economics of burnup credit and nonburnup credit cask designs being considered as conditions for a new generation of spent fuel transportation casks. CASKCOM is parametric in the sense that its input data can be easily changed in order to analyze and compare the life cycle cost implications arising from alternative assumptions. The input data themselves are organized into two main groupings. The first grouping comprises a set of data which is independent of cask design. This first grouping does not change from the analysis of one cask design to another. The second grouping of data is specific to each individual cask design. This second grouping thus changes each time a new cask design is analyzed.

23560 (SAND–89-0018, pp. 203-225) **Overview of fuel management analysis methodology.** Ozer, O. (Electric Power Research Institute, Palo Alto, CA (USA)). Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

One issue that has been raised with regard to the acceptance of the burnup credit concept for cask design has been the accuracy of the methods utilized to determine the isotopic composition of spent fuel. In other words, how well can a utility determine the isotopic content, and therefore the reactivity, of a fuel assembly that has been exposed for three or four cycles in an operating power reactor? This issue is of importance in determining the safety margin requirements for the design of a burnup-credit cask. The objectives of this paper are to: (1) review the typical features of core analysis methodologies used by utility engineers for keeping track of the nuclear characteristics of individual fuel assemblies throughout their exposure lifetime, using the Electric Power Research Institute (EPRI) sponsored analysis package, ARMP-02 as an example, (2) summarize the validation that such a methodology is subjected to, and (3) demonstrate the accuracy of utility spent fuel isotopics and reactivity predictions.

23561 (SAND–89-0018, pp. 337-339) **Summary overview of the DOE (Department of Energy) burnup credit workshop.** Lake, W.H. (Office of Civilian Radiological Waste Management, Washington, DC (USA)). Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

The papers in these proceedings for the most part reflect the content of a 2-day workshop on burnup credit that was held in Arlington, Virginia, on February 23 and 24, 1988. The speakers at the workshop were asked to provide formal papers covering the

topics which they presented orally at the February workshop. The proceedings also include a paper by Dr. S.E. Turner which covers the topic of burnup distribution. Dr. Turner did not give a formal presentation at the workshop, but because of the interest in the important results which he discovered at the workshop, he was asked to provide a paper. The workshop was intended to be both comprehensive and objective. The speakers and participants who were invited represented a broad range of interests and specialities in the areas of cask development and criticality. Because the issue of burnup credit cuts across many areas, the group included participants with experience in reactor operations, fuel storage, and transportation. The intention of the diversity was to provide an environment that would promote the sharing of knowledge and ideas. The format of the workshop was developed in the hope of providing an opportunity for a free and open exchange for all the participants.

0520 Waste Management

Refer also to citation(s) 23541, 23549, 23550, 23620, 23623, 23624, 23726, 23769, 23911, 24413, 24414, 24415, 24416, 24417, 24418, 24419, 24420, 24421, 24422, 24423, 24424, 24432, 25211

23562 (BNL–43887) **The role of accelerators in the nuclear fuel cycle.** Takahashi, Hiroshi. Brookhaven National Lab., Upton, NY (USA). [1990]. 29p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-900156–4: 2. international symposium on advanced nuclear energy research - evolution by accelerators, Mito (Japan), 24-26 Jan 1990). Order Number DE90008823. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The use of neutrons produced by the medium energy proton accelerator (1 GeV–3 GeV) has considerable potential in reconstructing the nuclear fuel cycle. About 1.5 ~ 2.5 ton of fissile material can be produced annually by injecting a 450 MW proton beam directly into fertile materials. A source of neutrons, produced by a proton beam, to supply subcritical reactors could alleviate many of the safety problems associated with critical assemblies, such as positive reactivity coefficients due to coolant voiding. The transient power of the target can be swiftly controlled by controlling the power of the proton beam. Also, the use of a proton beam would allow more flexibility in the choice of fuel and structural materials which otherwise might reduce the reactivity of reactors. This paper discusses the rate of accelerators in the transmutation of radioactive wastes of the nuclear fuel cycles. 34 refs., 17 figs., 9 tabs.

23563 (BNL-NUREG–43926) **Low-level waste shallow land burial source term container breach and waste form leaching model development.** Sullivan, T.M.; Suen, C.J. Brookhaven National Lab., Upton, NY (USA). [1990]. 14p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (CONF-900210–26: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90008521. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A general computer model has been developed to predict the release and transport of radionuclides from shallow land burial facilities. This model predicts the processes of unsaturated water flow, metallic container degradation, leaching of radionuclides from the waste form, and their movement away from the waste form. This paper discusses model development work for the container degradation and leaching aspects of the source term model. Application of these models and the sensitivity of release rates to model parameters, e.g., diffusion coefficients, corrosion rates, etc., are also discussed. 14 refs., 2 figs.

23564 (BNL-NUREG–43927) **BLT [Breach, Leach, and Transport]: A source term computer code for low-level waste shallow land burial.** Suen, C.J.; Sullivan, T.M. Brookhaven National Lab., Upton, NY (USA). [1990]. 21p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (CONF-900210–27: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90008520. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the development of a source term model for low-level waste shallow land burial facilities and separates the problem into four individual compartments. These are water flow, corrosion and subsequent breaching of containers, leaching of the waste forms, and solute transport. For the first and the last compartments, we adopted the existing codes, FEMWATER and FEMWASTE, respectively. We wrote two new modules for the other two compartments in the form of two separate Fortran subroutines – BREACH and LEACH. They were incorporated into a modified version of the transport code FEMWASTE. The resultant code, which contains all three modules of container breaching, waste form leaching, and solute transport, was renamed BLT (for Breach, Leach, and Transport). This paper summarizes the overall program structure and logistics, and presents two examples from the results of verification and sensitivity tests. 6 refs., 7 figs., 1 tab.

23565 (BNWL-CC–2142) **Release of radioiodine during processing of irradiated ^{237}Np targets.** Lerch, R.E. Battelle-Northwest, Richland, WA (USA). Pacific Northwest Lab. Jun 1969. 18p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. Order Number DE90008590. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Sixteen graphite-neptunium oxide target elements have been irradiated in conjunction with Hanford's plutonium-238 production demonstration program. The substitution of the graphite for aluminum as the matrix material raised the question of possible increased release of organic iodides during the chemical processing of the sixteen graphite target elements. The organic iodides are presumably formed from reaction of iodine with possible organic impurities within the graphite. Since conventional scrubbers will not absorb the organic iodides and since the relative amount of radioiodine in the fuel is very high in comparison to the amount that can be released to the atmosphere experiments were initiated to measure the amount of organic iodide released during processing of the graphite targets. Release of organic iodide from three other types of targets, aluminum-neptunium oxide, uranium metal, and uranium oxide-plutonium oxide, was also investigated for comparison to the graphite target elements. This report summarizes the results of these experiments. 14 refs., 1 fig., 2 tabs.

23566 (CONF-900406–44) **Preparing a Safety Analysis Report using the building block approach.** Herrington, C.C. Science Applications International Corp., Las Vegas, NV (USA). [1990]. 4p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC08-87NV10576. From International conference for high-level radioactive waste management; Las Vegas, NV (USA); 8-12 Apr 1990. Order Number DE90008299. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The credibility of the applicant in a licensing proceeding is severely impacted by the quality of the license application, particularly the Safety Analysis Report. To ensure the highest possible credibility, the building block approach was devised to support the development of a quality Safety Analysis Report. The approach incorporates a comprehensive planning scheme that logically ties together all levels of the investigation and provides the direction necessary to prepare a superior Safety Analysis Report.

23567 (CONF-900406–45) **Evaluating and controlling the characteristics of the nuclear waste in the FWMS using waste stream analysis model.** Andress, D. (Andress (David) and Associates, Inc., Kensington, MD (USA)); McLeod, N.B.; Joy, D.S. Oak Ridge National Lab., TN (USA). [1990]. 12p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC05-84OR21400. From International conference for high-level radioactive waste management; Las Vegas, NV (USA); 8-12 Apr 1990. Order Number DE90008562. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Waste Stream Analysis (WSA) Model is used by the Department of Energy to model the item and location dependent properties of the nuclear waste stream in the Federal Waste Managements System and at utility spent fuel storage facilities. WSA can simulate a wide variety of FWMS configurations and operating strategies and can select and sequence spent fuel for optimal efficiency in the FWMS while minimizing adverse impact on the utility

sector. WSA tracks each assembly from the time of discharge to ultimate geologic disposal including all shipping cask and waste package loadings and both at-reactor and FWMS consolidation. WSA selects the highest capacity shipping cask or waste package that does not violate external dose rate or heat limitations for a group of spent fuel assemblies to be containerized. This paper presents an overview of the Waste Stream Analysis Model and a number of key results from a set of coordinated SIMS runs, which illustrates both the impact of waste characteristics on system performance and the ability to control waste characteristics by use of selection and sequencing strategies. 7 refs., 6 figs.

23568 (CONF-900406–46) **Systems Integration Operations/ Logistics Model (SOLMOD).** Vogel, L.W. (Science Applications International Corp., McLean, VA (USA)); Joy, D.S. Oak Ridge National Lab., TN (USA). [1990]. 7p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC05-84OR21400. From International conference for high-level radioactive waste management; Las Vegas, NV (USA); 8-12 Apr 1990. Order Number DE90008567. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

SOLMOD is a discrete event simulation model written in FORTRAN 77 and operates in a VAX or PC environment. The model emulates the movement and interaction of equipment and radioactive waste as it is processed through the FWMS. SOLMOD can be used to measure the impacts of different operating schedules and rules, system configurations, reliability, availability, maintainability (RAM) considerations, and equipment and other resource availabilities on the performance of processes comprising the FWMS and how these factors combine to determine overall system performance. Model outputs are a series of measurements of the amount and characteristics of waste at selected points in the FWMS and the utilization of resources needed to transport and process the waste. The model results may be reported on a yearly, monthly, weekly, or daily basis to facilitate analysis. 3 refs., 3 figs., 2 tabs.

23569 (CONF-900406–47) **Requirements for controlling a repository's releases of carbon-14 dioxide; the high costs and negligible benefits.** Park, U Sun; Pflum, C.G. Science Applications International Corp., Las Vegas, NV (USA). [1990]. 13p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC08-87NV10576. From International conference for high-level radioactive waste management; Las Vegas, NV (USA); 8-12 Apr 1990. Order Number DE90008875. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A repository excavated within the unsaturated zone may release carbon (C)-14 dioxide in amounts that exceed limits imposed by the Environmental Protection Agency (EPA) and the Nuclear Regulatory Commission (NRC). The release would not threaten the general population, but may expose some hypothetical maximally exposed individual to 0.0005 millirems/year. Yet a repository's releases of C-14 dioxide are strictly regulated, perhaps unintentionally. The EPA and NRC regulations could force the Department of Energy to design and fabricate an expensive 10,000-year waste package solely for the sake of controlling releases of C-14 dioxide. This paper argues that the repository regulations should exempt releases of C-14 dioxide or at least impose more equitable limits. 21 refs., 1 tab.

23570 (CONF-900406–48) **A waste package strategy for regulatory compliance.** Stahl, D. (Science Applications International Corp., Las Vegas, NV (USA)); Cloninger, M.O. Science Applications International Corp., Las Vegas, NV (USA). [1990]. 14p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC08-87NV10576. From International conference for high-level radioactive waste management; Las Vegas, NV (USA); 8-12 Apr 1990. Order Number DE90008874. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper summarizes the strategy given in the Site Characterization Plan for demonstrating compliance with the post closure performance objectives for the waste package and the Engineered Barrier System contained in the Code of Federal Regulations. The strategy consists of the development of a conservative waste package design that will meet the regulatory requirements with sufficient margin for uncertainty using a multi-barrier approach that takes advantage of the unsaturated nature of the Yucca Mountain site. 7 refs., 1 fig.

23571 (CONF-900406–49) **Approach to developing a ground-motion design basis for facilities important to safety at Yucca Mountain.** King, J.L. Science Applications International Corp., Las Vegas, NV (USA). [1990]. 7p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC08-87NV10576. From International conference for high-level radioactive waste management; Las Vegas, NV (USA); 8-12 Apr 1990. Order Number DE90008876. Available from NTIS, PC A02/MF A01; OSTI; INIS.

The Department of Energy has proposed a methodology for developing a ground-motion design basis for prospective facilities at Yucca Mountain that are important to safety. The methodology utilizes a quasi-deterministic construct that is designed to provide a conservative, robust, and reproducible estimate of ground motion that has a one-in-ten chance of occurring during the preclosure period. This estimate is intended to define a ground-motion level for which the seismic design would ensure minimal disruption to operations; engineering analyses to ensure safe performance in the unlikely event that the design basis is exceeded are a part of the proposed methodology. 8 refs.

23572 (CONF-900406–50) **Implementation of NUREG-1318 guidance within the Yucca Mountain Project.** La Monica, L.B.; Waddell, J.D.; Hardin, E.L. Science Applications International Corp., Las Vegas, NV (USA). [1990]. 6p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC08-87NV10576. From International conference for high-level radioactive waste management; Las Vegas, NV (USA); 8-12 Apr 1990. Order Number DE90008877. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The US Department of Energy's Yucca Mountain Project is implementing a quality assurance program that fulfills the requirements of the US Nuclear Regulatory Commission (NRC). Additional guidance for this program was provided in NUREG 1318, "Technical Position on Items and Activities in the High-Level Waste Geologic Repository Program Subject to Quality Assurance Requirements" for identification of items and activities important to public radiological safety and waste isolation. The process and organization for implementing this guidance is discussed. 3 refs., 2 figs.

23573 (CONF-900406–51) **Yucca Mountain Project public interactions.** Reilly, B.E. Science Applications International Corp., Las Vegas, NV (USA). [1990]. 6p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC08-87NV10576. From International conference for high-level radioactive waste management; Las Vegas, NV (USA); 8-12 Apr 1990. Order Number DE90008878. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The US Department of Energy (DOE) is committed to keeping the citizens of Nevada informed about activities that relate to the high-level nuclear waste repository program. This paper presents an overview of the Yucca Mountain Project's public interaction philosophy, objectives, activities and experiences during the two years since Congress directed the DOE to conduct site characterization activities only for the Yucca Mountain site.

23574 (CONF-900406–52) **Linkage between site characterization program and performance and design data needs.** Blanchard, M.B. (USDOE Nevada Operations Office, Las Vegas, NV (USA)); Dobson, D.C.; Younker, J.L.; Voegele, M.D. Science Applications International Corp., Las Vegas, NV (USA). [1990]. 3p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC08-87NV10576. From International conference for high-level radioactive waste management; Las Vegas, NV (USA); 8-12 Apr 1990. Order Number DE90008807. Available from NTIS, PC A02/MF A01; OSTI; INIS.

The basis for identifying site-specific data needs for the Yucca Mountain site was a thorough review and evaluation of the regulatory requirements for a geologic repository. The US Nuclear Regulatory Commission's (NRC) regulation governing disposal of high-level waste in a geologic repository utilizes a multiple barrier approach that includes reliance on both engineered and natural elements. Given an understanding of the regulatory requirements, the next step was to identify the natural features of the site and the components of the engineered barriers considered most likely to make significant contributions to isolation of waste at Yucca Mountain. The intent was to develop a site testing program that focused

on understanding those natural site characteristics and processes most likely to contribute to waste isolation; and providing site data necessary to design and assess the performance of engineered barriers. 3 refs., 3 figs.

23575 (CONF-900406–53) **Plans for characterization of the potential geologic repository site at Yucca Mountain, Nevada.** Dobson, D.C. (USDOE Nevada Operations Office, Las Vegas, NV (USA)); Blanchard, M.B.; Voegele, M.D.; Younker, J.L. Science Applications International Corp., Las Vegas, NV (USA). [1990]. 4p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC08-87NV10576. From International conference for high-level radioactive waste management; Las Vegas, NV (USA); 8-12 Apr 1990. Order Number DE90008808. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Site investigations in the vicinity of the potential repository site at Yucca Mountain, Nevada, have occurred for many years. Although information from previous site investigations was adequate to support preliminary evaluations by the US Department of Energy (DOE) in the Environmental Assessment and to develop conceptual repository and waste package designs, this information is insufficient to proceed to the advanced designs and performance assessments required for the license application to the US Nuclear Regulatory Commission (NRC). Therefore, intensive site characterization is planned, as described in the December 1988 Site Characterization Plan (SCP). The data acquisition activities described in the SCP are focused on obtaining information to allow evaluations of the natural and engineered barriers considered potentially relevant to repository performance. The site data base must be adequate to allow predictions of the range of expected variation in geologic conditions over the next 10,000 years, as well as predictions of the probabilities for catastrophic geologic events that could affect repository performance. 4 refs., 4 figs.

23576 (CONF-8911175–1) **The global coastal hazards data base.** Gornitz, V. (National Aeronautics and Space Administration, New York, NY (USA). Goddard Inst. for Space Studies); White, T.W. Oak Ridge National Lab., TN (USA). [1989]. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Workshop on future climate change and radioactive waste disposal; Norwich (UK); 1-3 Nov 1989. Order Number DE90008746. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A rise of sea level between 0.5 and 1.5 m, caused by predicted climate warming in the next century, could jeopardize low-lying radioactive waste disposal sites near the coast, due to permanent and episodic inundation, increased shoreline retreat, and changes in the water table. The effects of global sea level rise on the shoreline will not be spatially uniform. Therefore, site selection will depend on assessment of these differential vulnerabilities, in order to avoid high-risk coasts. The coastal hazards data base described here could provide an appropriate framework. The coastal hazards data base integrates relevant topographic, geologic, geomorphologic, erosional and subsidence information in a Geographic Information System (GIS), to identify high-risk shorelines characterized by low coastal relief, an erodible substrate, present and past evidence of subsidence, extensive shoreline retreat, and high wave/tide energies. Data for seven variables relating to inundation and erosion hazards are incorporated into the ORNL ARC/INFO Geographic Information System (GIS). Data compilation has been completed for the US and is being extended to North America, and ultimately the world. A coastal vulnerability index (CVI) has been designed to flag high risk coastal segments. 17 refs., 2 figs., 2 tabs.

23577 (DOE/NV/10576–19) **Native American plant resources in the Yucca Mountain Area, Nevada.** Stoffle, R.W. (Michigan Univ., Ann Arbor, MI (USA). Inst. for Social Research); Evans, M.J.; Halmo, D.B.; Niles, W.E.; O'Farrell, J.T. Science Applications International Corp., Las Vegas, NV (USA). Nov 1989. 142p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC08-87NV10576. Order Number DE90008155. Available from NTIS, PC A08/MF A01; OSTI; INIS; GPO Dep.

This report presents Native American interpretations of and concerns for plant resources on or near Yucca Mountain, Nevada. This one of three research reports regarding Native American cultural resources that may be affected by site characterization activities related to the Yucca Mountain high-level radioactive waste disposal facility. Representatives of the sixteen involved American Indian tribes identified and interpreted plant resources as part of a consultation relationship between themselves and the US Department of Energy (DOE). Participants in the ethnobotany studies included botanists who have conducted, and continue to conduct, botanical studies for the Yucca Mountain Project. This report is to be used to review research procedures and findings regarding the process of consulting with the sixteen tribes, interviews with tribal plant specialists and elders, and findings from the ethnobotanical visits with representatives of the sixteen tribes. An annual report will include a chapter that summarizes the key findings from this plant resources study. 23 refs., 75 figs., 39 tabs.

23578 (DOE/NV/10576–21) **Literature review and ethnohistory of Native American occupancy and use of the Yucca Mountain Region: Yucca Mountain Project, interim report.** Stoffle, R.W. (Michigan Univ., Ann Arbor, MI (USA). Inst. for Social Research); Olmsted, J.E.; Evans, M.J. Science Applications International Corp., Las Vegas, NV (USA); Michigan Univ., Ann Arbor, MI (USA). Inst. for Social Research. Jan 1990. 197p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC08-87NV10576. Order Number DE90008156. Available from NTIS, PC A10/MF A01; OSTI; INIS; GPO Dep.

This report presents a review of the literature concerning Native American occupancy and use of the Yucca Mountain area and vicinity. It draws on a wide range of material, including early traveler reports, government documents, ethnographic and historical works, and local newspapers. The report complements two other concurrent studies, one focused on the cultural resources of Native American people in the study area and the other an ethnobotanical study of plant resources used by Native American people in the study area. The literature review has had two principal purposes: to determine the completeness of the Yucca Mountain Native American study design and to contribute to the understanding of the presence of Native American people in the Yucca Mountain area. A review of the existing literature about the Yucca Mountain area and southern Nye County, supplemented by the broader literature about the Great Basin, has verified three aspects of the study design. First, the review has aided in assessing the completeness of the list of Native American ethnic groups that have traditional or historical ties to the site. Second, it has aided in the production of a chronology of Native American activities that occurred on or near the site during the late nineteenth and early twentieth centuries. Third, it has helped to identify the location of cultural resources, including burials and other archaeological sites, in the study area and vicinity. 200 refs., 16 figs., 6 tabs.

23579 (DOE/OSTI–3406-Suppl.1-Add.3) **Yucca Mountain Project bibliography, January–June 1989: An update.** Henline, D.M. (USDOE Office of Scientific and Technical Information, Oak Ridge, TN (USA)); Bales, J.D. (eds.). USDOE Office of Scientific and Technical Information, Oak Ridge, TN (USA). Mar 1990. 15p. Sponsored by U.S. DOE Radioactive Waste Management. Order Number DE89014637. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This update contains information on the Yucca Mountain Project that was added to the Energy Data Base (EDB) during the first six months of 1989. Prior to August 5, 1988, this project was called the Nevada Nuclear Waste Storage Investigations. The update is categorized by principal project participant organizations, and items are arranged in chronological order according to publication date. Participant-sponsored subcontractor reports, meeting papers, and journal articles are included with sponsoring organization.

23580 (DOE/RL–89-32) **Hanford Site Waste Management Plan.** USDOE Richland Operations Office, WA (USA). Dec 1989. 98p. Sponsored by U.S. DOE Defense Programs. Order Number DE90008175. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This 1989 Hanford Site Waste Management Plan (HWMP) responds to the annual reporting requirement in the US Department of Energy (DOE) Order 5820.2A, Radioactive Waste Management. The HWMP addresses the Hanford Site, which is managed by the DOE-Richland Operations Office. The HWMP is an annual report that describes how waste management operations are conducted,

what facilities are being used to manage the wastes, what forces are acting to change current waste management systems, and what plans are in store for the current fiscal year. The scope of the HWMP includes the management of both radioactive and hazardous constituents in the waste, whether these are separated or mixed.

23581 (DOE-RW–89.052) **Earthquake effects on groundwater systems: an introductory review.** Department of the Environment, London (UK); Dames and Moore International, Twickenham (UK). Sep 1988. 26p. Contract PECD-7/9/200. (DM-TR–10). Order Number DE90622055. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This report presents an introductory review of the potential effects of earthquakes on groundwater systems with respect to the performance of underground repositories for radioactive waste in Britain. An approach to modelling these effects within the scope of general environmental simulation codes is presented. The relevant literature is reviewed and it is concluded that, although pertinent information exists, no clear relationship between seismic intensity and the degree of fracturing has been established. Recommendations are made for further work on fracture development to complement existing research into the effects of long-term changes on the integrity of radioactive waste disposal facilities. (author).

23582 (DOE-RW–89.089) **Waste management and radiological safety implications of using plutonium as a fuel in UK thermal reactors.** Wakerley, M.W. (Associated Nuclear Services, Epsom (UK)); Burholt, G.D.; Palit, A. Department of the Environment, London (UK). Aug 1989. 73p. Contract PECD-7/9/389. (ANS-R–772-2). Order Number DE90622052. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

This report presents the results of a study of the waste management and radiological safety implications of a potential strategy of plutonium recycle in the form of mixed oxide fuel (MOX) in Advanced Gas cooled Reactors (AGRs) or Pressurised Water Reactors (PWRs) in the UK. A review has been made of the experience in the prediction of reactor physics parameters for MOX fuel, the fabrication of MOX fuel and of reactor operator experience. Additionally, the aspects of plutonium oxide and MOX fuel handling, transport and processing have been examined. The main conclusions of the study were that the volumes of solid wastes and the public and operator doses arising from plutonium handling and MOX fuel fabrication are not a large proportion of those associated with the fuel cycle; volumes of solid wastes and the public and operator doses from the use of plutonium fuel in thermal reactors are not markedly different from those when slightly enriched uranium fuel is used; reprocessing of a small amount of MOX fuel in THORP beyond 2002 appears feasible and overall waste volumes and doses are similar for the UO_2 and UO_2/MOX cases; direct disposal of MOX fuel, as an alternative to reprocessing, should pose few additional problems compared with the direct disposal of UO_2 fuel; use of MOX fuel in AGRs is unfavourable on cost grounds. (author).

23583 (DOE/RW–0217P) **Progress report on the scientific investigation program for the Nevada Yucca Mountain site, September 15, 1988–September 30, 1989: Nuclear Waste Policy Act (Section 113), Number 1.** USDOE Office of Civilian Radioactive Waste Management, Washington, DC (USA). Feb 1990. 75p. Sponsored by U.S. DOE Radioactive Waste Management. Available from OSTI; INIS.

The Department of Energy (DOE) has prepared this report on the progress of site characterization activities at Yucca Mountain in southern Nevada. This report is the first of a series of reports that will hereafter be issued at intervals of approximately 6-months during site characterization. The DOE's plans for site characterization are described in the Site Characterization Plan (SCP) for the Yucca Mountain site. The SCP has been reviewed and commented on by the NRC, the State of Nevada, the affected units of local government, other interested parties, and the public. More detailed information on plans for site characterization is being presented in study plans for the various site characterization activities. This progress report presents short summaries of the status of site characterization activities and cites technical reports and research products that provide more detailed information on the activities. The report provides highlights of work started during the reporting period, work in progress, and work completed and documented during the reporting period. In addition, the report is the vehicle for discussing major changes, if any, to the DOE's site characterization program resulting from ongoing collection and evaluation of site information; the development of repository and waste-package designs; receipt of performance-assessment results; and changes, if any, that occur in response to external comments on the site characterization programs. 80 refs.

23584 (DOE/RW–0266P) **Performance Assessment Strategy Plan for the Geologic Repository Program.** USDOE Office of Civilian Radioactive Waste Management, Washington, DC (USA). Jan 1990. 144p. Sponsored by U.S. DOE Radioactive Waste Management. Available from OSTI; INIS.

Performance assessment is a major constituent of the program being conducted by the US Department of Energy (DOE) to develop a geologic repository. Performance assessment is the set of activities needed for quantitative evaluations to assess compliance with the performance requirements in the regulations for a geologic repository and to support the development of the repository. The strategy for these evaluations has been documented in the Performance Assessment Strategy Plan (DOE, 1989). The implementation of the performance assessment strategy is defined in this document. This paper discusses the scope and objectives of the implementation plan, the relationship of the plan to other program plans, summarizes the performance assessment areas and the integrated strategy of the performance assessment program. 1 fig., 3 tabs.

23585 (DOE/RW–0267P) **Performance assessment implementation plan for the geologic repository program.** USDOE Office of Civilian Radioactive Waste Management, Washington, DC (USA). Jan 1990. 154p. Sponsored by U.S. DOE Radioactive Waste Management. Available from OSTI; INIS.

Performance assessment is a major constituent of the program being conducted in the Civilian Radioactive Waste Management (CRWM) Program of the US Department of Energy (DOE) to develop a geologic repository. Performance assessment is the set of activities needed for quantitative evaluations of repository-system performance to access compliance with regulations and to support the development of the geologic repository. To define the strategy for these evaluations, the DOE has developed this performance assessment strategy plan. This document discusses the need for such a strategy, the objectives and scope of the strategy plan, the relationship of the plan to other program plans. Additionally, it defines performance assessment and describes the roles of performance assessment in this program, discusses concepts and general strategies needed for performance assessment, outlines the content of the Safety Analysis Report, summarizes the requirements for the repository Environmental Impact Statement, discusses the requirements that apply to the site-suitability analyses and describes the site characterization. 10 figs., 7 tabs.

23586 (NUREG/CR–5398) **Technical basis for review of high-level waste repository modeling.** Price, L.L. (Sandia National Labs., Albuquerque, NM (USA)); Gallegos, D.P.; Olague, N.E.; Wahi, K.K.; Goodrich, M.T.; Brosseau, D.A. Nuclear Regulatory Commission, Washington, DC (USA). Div. of High-Level Waste Management; Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 37p. Sponsored by Nuclear Regulatory Commission. (SAND–89-1557). Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

Both the US Environmental Protection Agency (EPA) and the US Nuclear Regulatory Commission (NRC) have promulgated regulations regarding the performance of geologic repositories for the disposal of high-level nuclear waste. One of the responsibilities of the US Department of Energy (DOE) is to demonstrate compliance with the appropriate regulations. The DOE will most likely use extensive numerical modeling to show compliance with the various quantitative requirements. These analyses will then be evaluated by the NRC. There are different levels of evaluation: peer review, conservative estimates,used of existing models/codes, and development of models/codes by the NRC. The intensity of the review will vary from analysis to analysis, depending on the importance of the analysis, the acceptability of the conceptual model behind the

analysis and the solution technique used, and the potential for increasing confidence in the system description, should the NRC decide to develop its own models/codes. An appropriate level of review can be determined by applying these four criteria in a specific manner. 24 refs.

23587 (NWTRB–90008658) **First report to the US Congress and the US Secretary of Energy.** Nuclear Waste Technical Review Board, Washington, DC (USA). Mar 1990. 82p. Available from GPO; OSTI; U.S. Nuclear Waste Technical Review Board, 1111 18th Street N.W., Suite 801, Washington, DC 20036.

The disposal of the Nation's spent nuclear fuel and high-level waste has been studied for many years. The Nuclear Waste Policy Act of 1982 and the subsequent Nuclear Waste Policy Amendments Act (NWPAA) of 1987 provide the legislative framework under which the Department of Energy (DOE) must operate when evaluating potential sites for the geologic disposal of spent nuclear fuel and high-level waste. Additionally, the DOE must comply with regulations published by the Environmental Protection Agency (EPA) in 40 CFR 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes" and the Nuclear Regulatory Commission (NRC) in 10 CFR 60. "Disposal of High-Level Radioactive Wastes in Geologic Repositories." The DOE also operates under its own regulation, 10 CFR 960. "General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories." The DOE has devoted considerable resources to this program, which is managed by the Office of Civilian Radioactive Waste Management (OCRWM). Disposal of spent nuclear fuel and high-level waste in a geologic repository has never before been done anywhere in the world. Since this is a first-of-a-kind facility, extreme care must be taken to ensure that all environmental and public health standards are met during its required long life. Yucca Mountain was designated by the NWPAA as the sole site to be characterized for the disposal of spent nuclear fuel and high-level waste (see "Description of the Yucca Mountain Site"). It is important to recognize that Yucca Mountain has not been chosen for a permanent disposal site or repository. Rather, it is the candidate site to be characterized to determine whether or not it meets the myriad requirements set forth in existing regulations for the long-term disposal of spent nuclear fuel and high-level waste. 8 figs.

23588 (ORNL/TM–11332) **Proceedings of the workshop on the management of radioactively contaminated soils, Knoxville, Tennessee, November 10, 1988.** Lomenick, T.F. (ed.). Oak Ridge National Lab., TN (USA). Nov 1989. 25p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. (CONF-8811174–Summ.: Workshop on the management of radioactively contaminated soils, Knoxville, TN (USA), 10 Nov 1988). Order Number DE90008268. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The management of large quantities of soils contaminated with generally low concentrations of fission products and/or other radioactive materials is a major problem at many Department of Energy-(DOE-) owned facilities. To initiate work toward common solutions, on a DOE-wide basis, to this perplexing and difficult problem, a one-day workshop on "The Management of Radioactively Contaminated Soils" was held at the Knoxville Hilton Hotel on Thursday, November 10, 1988. With selected representatives from all of the DOE sites that possess and/or generate contaminated soils, along with experts in regulatory affairs and soil characterization, many of the important issues that bear on the solutions to problems of contaminated soils were addressed. Topical sessions focused on are characterization, present practices, regulations, and interim and performance-based policies. 2 tabs.

23589 (PNL–7142) **Hanford Waste Vitrification program pilot-scale ceramic melter Test 23.** Goles, R.W.; Nakaoka, R.K. Pacific Northwest Lab., Richland, WA (USA). Feb 1990. 220p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE90007915. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

The pilot-scale ceramic melter test, was conducted to determine the vitrification processing characteristics of simulated Hanford Waste Vitrification Plant process slurries and the integrated performance of the melter off-gas treatment system. Simulated melter feed was prepared and processed to produce glass. The vitrification system, achieved an on-stream efficiency of greater than 98%. The melter off-gas treatment system included a film cooler, submerged bed scrubber, demister, high-efficiency mist eliminator, preheater, and high-efficiency particulate air filter (HEPA). Evaluation of the off-gas system included the generation, nature, and capture efficiency of gross particulate, semivolatile, and noncondensible melter products. 17 refs., 48 figs., 61 tabs.

23590 (PNL–7273) **Cesium recovery using Savannah River Laboratory resorcinol-formaldehyde ion exchange resin.** Bray, L.A.; Elovich, R.J.; Carson, K.J. Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 17p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. Order Number DE90007914. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A new ion exchange resin has been developed by the Savannah River Laboratory (SRL) for the recovery of radioactive ^{137}Cs from alkaline wastes produced by reprocessing fuels from nuclear reactors. The SRL resin is a condensation polymer made from resorcinol and formaldehyde. It has been shown to be stable to chemical and radiation attack in the highly concentrated and caustic supernatant waste. Small-scale testing was completed with excellent results. The Pacific Northwest Laboratory (PNL) was requested to initiate a test program designed to provide additional experimental data needed to support further consideration of the resorcinol-formaldehyde ion exchange treatment for the Savannah River Site (SRS) alkaline waste. 2 refs., 2 figs., 5 tabs.

23591 (PNL–7280) **Interim reclamation report, Basalt Waste Isolation project: Boreholes, 1989.** Brandt, C.A.; Rickard, W.H. Jr.; Hefty, M.G. Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 87p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC06-76RL01830. Order Number DE90008802. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

In 1968, a program was started to assess the feasibility of storing Hanford Site defense waste in deep caverns constructed in basalt. This program was expanded in 1976 to include investigations of the Hanford Site as a potential location for a mined commercial nuclear waste repository. An extensive site characterization program was begun to determine the feasibility of using the basalts beneath the Hanford Site for the repository. Site research focused primarily on determining the direction and speed of groundwater movement, the uniformity of basalt layers, and tectonic stability. Some 98 boreholes were sited, drilled, deepened, or modified by BWIP between 1977 and 1988 to test the geologic properties of the Site. On December 22, 1987, President Reagan signed into law the Nuclear Waste Policy Amendments Act of 1987, which effectively stopped all repository-related activities except reclamation of disturbed lands at the Hanford Site. This report describes the development of the reclamation program for the BWIP boreholes, its implementation, and preliminary estimates of its success. The goal of the reclamation program is to return sites disturbed by the repository program as nearly as practicable to their original conditions using native plant species. 48 refs., 28 figs., 14 tabs.

23592 (PNL-SA–17157) **Evaluating uncertainty in reactive-solute transport calculations.** Arthur, R.C.; Criscenti, L.S. Pacific Northwest Lab., Richland, WA (USA). Nov 1989. 19p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC06-76RL01830. (CONF-891120–11: Migration '89: 2nd international conference on chemistry and migration behavior of actinides and fission products in the geosphere, Monterey, CA (USA), 6-10 Nov 1989). Order Number DE90008630. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Calculations using both mechanistic and empirical (i.e., Kd) solute-attenuation submodels in an explicitly coupled reaction-transport computer code can be compared to identify conditions for which the empirical models are adequate for assessing the performance of geologic repositories for nuclear wastes. The approach is illustrated using a planned performance assessment strategy in which Kd values for Cs are calculated on the basis of the modal abundances and relative Cs-sorption affinities of zeolites, smectite, and glass present in tuffs underlying the candidate nuclear waste

repository at Yucca Mountain, Nevada. Thermodynamic considerations and site data characterizing the mineralogy along possible flow paths at Yucca Mountain indicate that zeolite metasomatism may result from minor variations in groundwater composition. A coupled reaction-transport code, CTM, is used to simulate the effects of these replacement reactions on Cs transport, and the results are compared to calculations using a Kd-attenuation model in which zeolite metasomatism is not considered. Calculations using the mechanistic model predict a cycle of attenuation and remobilization of Cs as sorptive clinoptilolite is progressively replaced by less sorptive mordenite. This secondary reaction front migrates more slowly than the fluid, but total Cs concentrations in the aqueous plus solid phases at the front increase continuously. The secondary front is not predicted in the Kd-model calculations, which as a consequence significantly underpredict total Cs concentrations in the flow path. 15 refs., 3 figs., 3 tabs.

23593 (PNL-SA–17194) **Thermodynamic modeling of cement/groundwater interaction as a tool for long-term performance assessment.** Criscenti, L.J.; Serne, R.J. Pacific Northwest Lab., Richland, WA (USA). Dec 1989. 10p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. (CONF-891119–111: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989). Order Number DE90008619. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The chemical behavior of cement in the natural environment is of interest because cement has been suggested as a means of containing low-level radioactive waste and as a barrier between radioactive-waste containers and the surrounding soil or rock. In this study, a geochemical model for cement leaching was developed, and predictions by the model were compared to results from a static leach test. Calcium concentrations and pH were adequately predicted by the model; however, other major leachate constituents, such as Al, Si, and SO_4, were poorly predicted. Additional experimental data and refinement of the model are both required to better predict the observed leachate concentrations. Accurate prediction of experimental results by a geochemical model would increase confidence in the model for use in long-term performance assessment. 19 refs., 1 fig., 4 tabs.

23594 (PNL-SA–17242) **In situ vitrification of soils containing various metals.** Buelt, J.L.; Farnsworth, R.K. Pacific Northwest Lab., Richland, WA (USA). Feb 1990. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. (CONF-900210–35: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90008628. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In situ vitrification (ISV) converts contaminated soil into a glass and crystalline product by melting it with electrical energy. Pacific Northwest Laboratory, the developer of ISV, is currently conducting research to extend the technology to buried wastes and underground tanks for the US Department of Energy. Since these types of wastes are anticipated to contain high concentrations of metals, new processing techniques are being developed and tested. In addition, the effects of metals on melt shape and on the solubility of heavy metals are being studied and tested. An electrode feeding technique has been developed and tested for processing high concentrations of metals. This concept has been successfully tested four times on engineering-scale equipment. 9 refs., 5 figs., 5 tabs.

23595 (PNL-SA–17284) **Chemical laboratory hazardous waste management at a DOE multiprogram national laboratory.** Turner, P.J. Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 6p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. (CONF-900210–34: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90008605. Available from NTIS, PC A03/MF A01; OSTI; INIS.

Pacific Northwest Laboratory (PNL), a United States Department of Energy (DOE) Multiprogram Energy Laboratory, is establishing a program for management of diverse small-quantity laboratory waste generated on site. Although the main emphasis of this program is "cradle-to-grave" tracking and treatment of hazardous chemical waste and mixed waste, low-level radioactive and transuranic (TRU) waste is also being included. With the program in operation, more than 95% of all regulated waste will be treated or destroyed on site. The cost savings will return the original investment in under six years and decrease the liability to PNL and DOE – a benefit with a potentially greater economic value. Tracking of hazardous waste will be mediated by a computer-based inventory and tracking system. The system will track all hazardous materials from receipt through final disposition, whether the material is destroyed or treated for disposal. It will allow user access to handling and hazards information as well as provide an updated inventory by location, user, and hazard type. Storage and treatment of waste will be performed by at least four facilities, made operational in three phases. 6 figs.

23596 (PNL-SA–17285) **Cleanout and decontamination of radiochemical hot cells.** Surma, J.E.; Holton, L.K. Jr.; Katayama, Y.B.; Gose, J.E.; Haun, F.E.; Dierks, R.D. Pacific Northwest Lab., Richland, WA (USA). Jan 1990. 25p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. (CONF-900210–30: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90008617. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Pacific Northwest Laboratory is developing and employing advanced remote and contact technologies in cleaning out and decontaminating six radiochemical hot cells at Hanford under the Department of Energy's Surplus Facilities Management Program. The program is using a series of remote and contact decontamination techniques to reduce costs and to significantly lower radiation doses to workers. Refurbishment of the cover blocks above the air lock trench reduced radiation exposure in the air lock and cleanout and decontamination of an analytical cell achieved a reduction in radioactive contamination. Nuclear Regulatory Commission-approved Type B burial boxes are also being used to reduce waste disposal costs and radiation doses. PNL is currently decommissioning its pilot-scale radioactive liquid-fed ceramic melter. Special tools have been developed and are being used to accomplish the world's first such effort. 4 refs., 5 figs.

23597 (PNL-SA–17319) **The calculated effects of isothermal boiling on tuff-water interactions.** Criscenti, L.J.; Arthur, R.A. Pacific Northwest Lab., Richland, WA (USA). Nov 1989. 26p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC06-76RL01830. (CONF-891120–12: Migration '89: 2nd international conference on chemistry and migration behavior of actinides and fission products in the geosphere, Monterey, CA (USA), 6-10 Nov 1989). Order Number DE90008632. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Radiogenic heat from the candidate high-level nuclear waste repository at Yucca Mountain, Nevada, could cause porewaters in the partially saturated host tuffs to boil during the first several hundred years following waste emplacement. We have evaluated whether changes in aqueous compositions caused by open-system boiling can significantly affect predicted reaction paths in tuff-water systems. Data were incorporated into a kinetic reaction path model. Boiling is simulated as an isothermal process in an open system involving irreversible exsolution of CO_2 from the liquid. In the current conceptual model, it is assumed that the exsolution rate of CO_2 is instantaneous compared to other mass-transfer reactions. 17 refs., 8 figs., 2 tabs.

23598 (PNL-SA–17633) **Simulating the water balance of an arid site.** Jones, T.L. Pacific Northwest Lab., Richland, WA (USA). Nov 1989. 201p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. Order Number DE90008626. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

Thesis submitted by T.L. Jones to Washington State University.

The purpose of this paper is to evaluate the ability of a numerical model based upon Darcy's law to simulate the field water balance of a sandy soil over a 5-year period. Water balance measurements were made for 10 lysimeters exposed to the arid climate of the Hanford Site. The lysimeters are filled with coarse sediments common to the area and have been kept free of vegetation throughout the experiment. The numerical model tested in this paper simulates the soil water balance from input data consisting of meteorological conditions and laboratory measurements of soil properties. The variability in data from the 10 lysimeters is used as

a guide in assessing a reasonable accuracy that should be expected from the simulation model. Section 2.0 of this report describes the lysimeter facility and the physical properties of the soil material used to fill the lysimeters. Section 3.0 describes the water balance data collected since 1984 and explains the key components of these data that will be used to evaluate the model simulations. Section 4.0 summarizes the mathematical and numerical model that is used to simulate the behavior of the lysimeters. Section 5.0 contains the model results and compares these results to the measured water balance data. 52 refs., 22 figs., 10 tabs.

23599 (PNL-SA-17690) **Treating metal-bearing wastes with a transportable test system.** Jones, E.O.; Stewart, T.L. Pacific Northwest Lab., Richland, WA (USA). Feb 1990. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. (CONF-9002104–1: 11. AESF/EPA conference on pollution control for the metal finishing industry, Miami, FL (USA), 5-9 Feb 1990). Order Number DE90008631. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Waste Acid Detoxification and Reclamation (WADR) process combines selective precipitation and vacuum distillation to remove heavy metals and recycle acids from spent acid streams. Now at the pilot-scale stage, the transportable system includes a flash separator, vacuum column, and support equipment to separate out the acids and heavy metals–leaving a clean water stream that can be reused or sent to sewer. Simulated spent acid wastes can be tested to determine potential waste volume reductions and acid recoveries. Preliminary testing can be performed in a laboratory-scale system with large-scale demonstration testing to follow if desired or necessary. 5 refs., 3 figs.

23600 (Rijnconsult–1983) **Study into an organization for collecting, processing and removing of radioactive waste.** Ministerie van Volksgezondheid en Milieuhygiene-Rijnconsult Collaboration. Adviesbureau Rijnconsult, Arnhem (Netherlands). Sep 1983. 100p. (In Dutch). Order Number DE90706073. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

This report presents the results of a study into a new organization for the collection, processing and removal of radioactive waste. At present these activities are carried out by the Dutch Energy Research Foundation (ECN). The new organization has to offer guarantees for a qualitatively responsible retrieval and processing of radioactive waste. It also has to be certain that the waste offered will not be send back, or even refused, if stagnation occurs in the removal. Finally the tariffs have to be not so prohibitive that they hinder a responsible handling with radioactive waste by the producers. An organization is advised which is self-employed with regard to management, directorate and materials. It is recommended to submit this organization in a limited liability company. This form of government may be supplemented optionally with a slight form of a cooperative association. (author). 10 refs.; 3 figs.; 11 tabs.

23601 (SAND–88-1387) **The thermal conductivity of seven thermal/mechanical units at Yucca Mountain, Nevada: Yucca Mountain Project.** Nimick, F.B. Sandia National Labs., Albuquerque, NM (USA). Jan 1990. 69p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. Order Number DE90008164. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

Measured thermal conductivity data are summarized for 29 samples of tuff units at Yucca Mountain. In situ thermal conductivities are estimated for seven thermal/mechanical Units. Existing data suggest that both matrix thermal conductivity and rock-mass thermal conductivity are temperature-independent; the exception to this statement is the change in the rock-mass thermal conductivity during the transition from the initial saturation state to a dehydrated condition. Comparison of estimated rock-mass thermal conductivities with data obtained on samples assumed to have retained in situ saturation values suggests that thermal conductivities obtained by the two methods are similar for welded units, but nonwelded samples probably dried before being wrapped and waxed at the drill site. 31 refs., 7 figs., 30 tabs.

23602 (SAND–89-0018, pp. 1-10) **Burnup credit issues in spent fuel transportation workshop - Overview and objectives.** Sanders, T.L. Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

Under the Nuclear Waste Policy Amendments Act (NWPAA) of 1987 the US DOE will ship spent fuels from commercial sites (reactors and storage facilities) to a federal repository using shipping casks certified by the US NRC. Requirements for shipping commercially generated, spent light water reactor (LWR) fuel to receiving facilities at the turn of the century will differ considerably from those existing in the US at present. The number of future shipments to repositories will represent a substantial increase over current experience as evidenced by comparison of the projected minimum transport rate of 3000 MTU/yr (metric tons uranium per year) with a total movement of 6000 MTU over the last 25 years in the US. Also, future casks will be required to only accommodate much older spent fuel. Since current casks are predominately designed for much shorter-cooled spent fuels (180 days out of the reactor), the development of more efficient, new generation casks is warranted because of the potential for large increases in payload capacity. As new casks are developed, private industry is being encouraged to be innovative in designing features to enhance both safety and operational efficiency.

23603 (SAND–89-2176C) **Progress in validation of structural codes for radioactive waste repository applications in bedded salt.** Munson, D.E. (Sandia National Labs., Albuquerque, NM (USA)); DeVries, K.L. Sandia National Labs., Albuquerque, NM (USA). [1990]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9005117–1: GEOVAL '90, Stockholm (Sweden), 14-17 May 1990). Order Number DE90007501. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Over the last nine years, coordinated activities in laboratory database generation, constitutive model formulation, and numerical code capability development have led to an improved ability of thermal/structural codes to predict the creep deformation of underground rooms in bedded salt deposits. In the last year, these codes have been undergoing preliminary validation against an extensive database collected from the large scale underground structural in situ tests at the Waste Isolation Pilot Plant (WIPP) in Southeastern New Mexico. This validation exercise has allowed the prediction capabilities to be evaluated for accuracy. We present here a summary of the predictive capability and the nature of the in situ database involved in the validation exercise. The WIPP validation exercise has proven to be especially productive. 7 refs., 4 figs.

23604 (SAND–89-2378C) **A proposed strategy for the validation of ground-water flow and solute transport models.** Davis, P.A. (Sandia National Labs., Albuquerque, NM (USA)); Goodrich, M.T. Sandia National Labs., Albuquerque, NM (USA). [1990]. 8p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (CONF-9005117–2: GEOVAL '90, Stockholm (Sweden), 14-17 May 1990). Order Number DE90007561. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Ground-water flow and transport models can be thought of as a combination of conceptual and mathematical models and the data that characterize a given system. The judgment of the validity or invalidity of a model depends both on the adequacy of the data and the model structure. This report proposes a validation strategy for testing both components independently. The strategy is based on the philosophy that a model cannot be proven valid, only invalid or not invalid. In addition, the authors believe that a model should not be judged in absence of its intended purpose. Hence, a flow and transport model may be invalid for one purpose but not invalid for another. 9 refs.

23605 (UCRL–100860) **A deformation and thermodynamic model for hydride precipitation kinetics in spent fuel cladding.** Stout, R.B. Lawrence Livermore National Lab., CA (USA). Oct 1989. 28p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-48. (CONF-891119–109: Materials Research Society fall meeting, Boston, MA (USA), 27

Nov - 2 dec 1989). Order Number DE90008541. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Hydrogen is contained in the Zircaloy cladding of spent fuel rods from nuclear reactors. All the spent fuel rods placed in a nuclear waste repository will have a temperature history that decreases toward ambient; and as a result, most all of the hydrogen in the Zircaloy will eventually precipitate as zirconium hydride platelets. A model for the density of hydride platelets is a necessary sub-part for predicting Zircaloy cladding failure rate in a nuclear waste repository. A model is developed to describe statistically the hydride platelet density, and the density function includes the orientation as a physical attribute. The model applies concepts from statistical mechanics to derive probable deformation and thermodynamic functionals for cladding material response that depend explicitly on the hydride platelet density function. From this model, hydride precipitation kinetics depend on a thermodynamic potential for hydride density change and on the inner product of a stress tensor and a tensor measure for the incremental volume change due to hydride platelets. The development of a failure response model for Zircaloy cladding exposed to the expected conditions in a nuclear waste repository is supported by the US DOE Yucca Mountain Project. 19 refs., 3 figs.

23606 (UCRL–102081) **Fabrication and closure development of corrosion resistant containers for Nevada's Yucca Mountain high-level nuclear waste repository.** Russell, E.W. (Lawrence Livermore National Lab., CA (USA)); Nelson, T.A.; Domian, H.A.; LaCount, D.F.; Robitz, E.S.; Stein, K.O. Lawrence Livermore National Lab., CA (USA). Nov 1989. 13p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-48. (CONF-900403–8: NACE Corrosion '90, Las Vegas, NV (USA), 23-27 Apr 1990). Order Number DE90008381. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

US Congress and the President have determined that the Yucca Mountain site in Nevada is to be characterized to determine its suitability for construction of the first US high-level nuclear waste repository. Work in connection with this site is carried out within the Yucca Mountain Project (YMP). Lawrence Livermore National Laboratory (LLNL) has the responsibility for designing, developing, and projecting the performance of the waste package for the permanent storage of high-level nuclear waste. Babcock & Wilcox (B&W) is involved with the YMP as a subcontractor to LLNL. B&W's role is to recommend and demonstrate a method for fabricating the metallic waste container and a method for performing the final closure of the container after it has been filled with waste. Various fabrication and closure methods are under consideration for the production of containers. This paper presents progress to date in identifying and evaluating the candidate manufacturing processes. 2 refs., 2 figs., 4 tabs.

23607 (WHC-EP–0182-20) **Tank Farm Surveillance and Waste status summary report for November 1989.** Hanlon, B.M. Westinghouse Hanford Co., Richland, WA (USA). Mar 1990. 44p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90008146. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report is Westinghouse Hanford Company's official inventory for high-level radioactive waste stored in underground tanks at the Hanford Site. Data that depict the status of stored, high-level waste and tank vessel integrity are contained within the report. The intent of the report is to provide data on each of the existing 177 underground waste tanks and provide supplemental information regarding tank anomalies and ongoing investigations.

23608 (WHC-EP–0182-21) **Tank Farm Surveillance and Waste status summary report for December 1989.** Hanlon, B.M. Westinghouse Hanford Co., Richland, WA (USA). Mar 1990. 43p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90008174. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report is Westinghouse Hanford Company's official inventory for high-level radioactive waste stored in underground tanks at the Hanford Site. Data that depict the status of stored, high-level waste and tank vessel integrity are contained within the report. The intent of the report is to provide data on each of the existing 177 underground waste tanks and provide supplemental information regarding tank anomalies and ongoing investigations.

23609 (WHC-EP–0182-22) **Tank Farm Surveillance and Waste status summary report for January 1990.** Hanlon, B.M. Westinghouse Hanford Co., Richland, WA (USA). Mar 1990. 42p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90008173. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report is Westinghouse Hanford Company's official inventory for high-level radioactive waste stored in underground tanks at the Hanford Site. Data that depict the status of stored, high-level waste and tank vessel integrity are contained within the report. The intent of the report is to provide data on each of the existing 177 underground waste tanks and provide supplemental information regarding tank anomalies and ongoing investigations.

23610 (WHC-EP–0258) **Westinghouse Hanford Company environmental surveillance annual report, calendar year 1988: 100 Areas.** Perkins, C.J. Westinghouse Hanford Co., Richland, WA (USA). Feb 1990. 108p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90008148. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

Near-field environmental surveillance of the Hanford 100 Areas is performed by Westinghouse Hanford Company to assess and control the impacts of operations. This involves sampling and analysis from the major environmental pathways of exposure to onsite workers. Results from the Westinghouse Hanford Environmental Surveillance Program for the Hanford 100 Areas are presented in this report. At 100-N Area, samples of ambient air, groundwater, vegetation, and surface soil were collected and analyzed. Direct radiation levels were also monitored at several locations. Samples of ambient air, vegetation, surface soil, and sediment were collected to monitor the environmental impact of the 1301-N and 1325-N Liquid Waste Disposal Facilities (LWDFs). Direct radiation surveys were conducted to each LWDF and along the Columbia River shoreline. At the retired 100 Areas, vegetation and surface soil samples were collected and analyzed. In addition, samples from groundwater monitoring wells located at 100-K Area were collected and analyzed. The results are provided in this report. 15 refs., 21 figs., 21 tabs.

23611 (WHC-EP–0321) **Single-shell tank systems engineering study work plan.** Garfield, J.S. Westinghouse Hanford Co., Richland, WA (USA). Jan 1990. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90008147. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report documents a work plan for a systems engineering study to be conducted in fiscal year 1990. The scope of the work addresses alternative means to permanently dispose of the nuclear and hazardous wastes contained in 149 single-shell tanks located on the Hanford Site in Richland, Washington. 2 refs., 5 figs., 1 tab.

23612 (WHC-SA–0217) **Real-time monitoring of Hanford mixed wastes at environmental levels.** Subrahmanyam, V.B.; Bruns, L.E. Westinghouse Hanford Co., Richland, WA (USA). Feb 1988. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-880601–55: American Nuclear Society annual meeting, San Diego, CA (USA), 12-16 Jun 1988). Order Number DE90008577. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Process requirements and environmental regulations place ever increasing demands on analytical techniques for quantifying radionuclides, transuranic elements (TRU), and other hazardous constituents. These measurements are desirable on a real-time basis at lower concentration levels and with improved minimum detection limits. In order to meet these changes new concepts, in addition to adapting proven methods to current needs, are being developed. This paper considered measurements for radioactive constituents of mixed wastes. Equipment and techniques for monitoring active processes and characterizing stored and aged wastes are discussed. 5 refs., 1 tab.

23613 (WHC-SA-0711) **Hanford Waste Vitrification Plant process description, process advancements, and Hanford Site interfaces.** Shah, K.R.; Stegen, G.E. Westinghouse Hanford Co., Richland, WA (USA). Feb 1990. 50p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-900210-25: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90007818. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Westinghouse Hanford Company has the lead responsibility for development, design, construction, and operation of the Hanford Waste Vitrification Plant. The Hanford Waste Vitrification Plant will be built for the US Department of Energy to vitrify existing and future liquid high-level and transuranic wastes produced by defense activities at the Hanford Site. Start of construction is scheduled for mid-1991. Hot startup currently is scheduled for December 1999, and acceleration of the hot startup schedule is under consideration. Requirements related to interfaces with existing Hanford Site facilities and other site-specific requirements are discussed in this paper. Design of the feed transfer and lag storage, radioactive liquid waste treatment and recycle, and process offgas treatment systems is significantly affected by site-specific requirements. Recent development in design of these systems are described. 9 figs., 1 tab.

23614 (Y/TS-83-Rev.5) **Y-12 Plant Long-Range Environmental and Waste Management Plan: Fiscal years 1989-1995.** Oak Ridge Y-12 Plant, TN (USA). 7 Apr 1989. 457p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OS21400. Order Number DE90008775. Available from NTIS, PC A20/MF A01 - OSTI; GPO Dep.

This report, the Y-12 Plant Long-Range Environmental and Waste Management Plan, is the annual update in a series begun at this installation in fiscal year 1985. The primary purpose of this report is to provide a thorough and systematic planning document to reflect the continuing process of site assessment, strategy development and planning for the current and long-term environmental issues, waste management practices, and remedial actions. The document also provides an estimate of the resources required to implement the current plan. This document is not intended to be a budget document but a tool to provide guidance to both Energy Systems and Department of Energy as to the order of magnitude of the resources and the time frame required to execute the strategy in the present revision of the plan. The near-term part of the plan is a well-defined assessment of the current program and ongoing capital projects and reflects the efforts perceived to be necessary to comply with all current state and federal regulations and DOE Orders. 12 figs., 51 tabs.

23615 **Accelerated leach testing of radionuclides from solidified low-level waste.** Pietrzak, R.F. (Brookhaven National Lab., Upton, NY (USA)); Fuhrmann, M.; Franz, E.M.; Heiser, J. III; Colombo, P. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 29(1): 164-167 (1989). DOE Contract AC02-76CH00016. (CONF-8904178-: Symposium on leaching tests, Dallas, TX (USA), 9-14 Apr 1989).

This paper describes some of the work performed to develop an accelerated leach test designed to provide data that show long-term leaching behavior of solidified waste in a relatively short period of testing (1,2). The need for an accelerated leach test stems from the fact that the response of an effectively solidified waste form to the leaching process is so slow that a very long time is required to complete a test which shows the long-term leaching behavior of a waste form. Because of time limitations, as well as economic considerations, most studies have been limited to the early stages of the leaching process which is predominantly controlled by diffusion, although acknowledged to be due to also dissolution, corrosion or ion-exchange.

23616 **Leaching of porous solids: Modeling of the leaching behavior of cylindrical specimens and its implications for the safe disposal of radioactive and hazardous chemical waste forms.** Anders, O.U. (Michigan Molecular Institute, Midland (USA)); Godbee, H.W. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 29(1): 192-194 (1989). (CONF-8904178-: Symposium on leaching tests, Dallas, TX (USA), 9-14 Apr 1989).

Leaching studies performed by Dow Chemical Company and ORNL in an attempt to identify leaching mechanisms is summarized. Liquids simulating typical wastes of pressurized water reactors and boiling water reactors was used. The samples were solidified using portland cements, cementitious admixtures (grouts), urea formaldehyde, and water-extended polyesters as solidification agents. The experiments were carried out by suspension of the cylindrical specimens in sufficient leachant to prevent significant modification of the chemical composition of the latter during each leaching interval. The parameter optimization code NEWBOX was used in the experiments. The results obtained permit significant insight as to the probable mechanisms involved in the leaching of the different types of materials. Recommendations as to solidification methods are discussed.

0530 Environmental Aspects

Refer also to citation(s) 23563, 23564, 23565, 23567, 23569, 23570, 23573, 23574, 23575, 23576, 23577, 23578, 23579, 23580, 23583, 23584, 23585, 23586, 23587, 23588, 23590, 23591, 23592, 23593, 23594, 23595, 23597, 23598, 23599, 23601, 23603, 23607, 23608, 23609, 23610, 23611, 23613, 23614, 23621, 23623, 23624, 24145

23617 (BNWL-CC-1992) **Mission 10, Columbia River Studies: Progress report on 02 research and development, July-December 1968.** Honstead, J.F.; Jaske, R.T. Pacific Northwest Lab., Richland, WA (USA). 13 Jan 1969. 12p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. Order Number DE90008591. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Various pathways may be postulated whereby members of the population living adjacent to the Hanford Plant can receive radiation exposure as a result of the plant operation. This project is concerned with investigations designed to evaluate the mechanisms of exposure of population groups by various pathways. The study will try to evaluate the effect of effluents released to the Columbia River and to the atmosphere. Here the exposure estimates depend upon evaluation of the average and extreme dietary habits of members of the affected population to assess the average and extreme exposure possibilities. These investigations will provide more precise estimates of exposure levels experienced by local residents and strengthen the confidence in effluent control provisions. The quantitative description of mechanisms of transfer of radioactive materials through various pathways may also be used to predict the effects of changes, such as new product operations or the release of additional plant areas for industrial or agricultural development.

23618 (PNL-SA-17283) **Information management systems for integrating the technical data and regulatory requirements of environmental restoration activities.** Geffen, C.A.; Garrett, B.A.; Walter, M.B. Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 11p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. (CONF-900210-29: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90008622. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Current environmental regulations require that comprehensive planning be conducted before remediating a hazardous waste site to characterize the nature and extent of site contamination, calculate the risk to the public, and assess the effectiveness of various remediation technologies. Remediation of Department of Energy (DOE) sites contaminated with hazardous or mixed wastes will require the effective integration of scientific and engineering data with regulatory and institutional requirements. The information management challenge presented by waste site cleanup activities goes beyond merely dealing with the large quantity of data that will be generated. The information must be stored, managed, and presented in a way that provides some consistency in approach across sites, avoids duplication of effort, and facilitates responses to requests for information from the regulators and the public. This paper provides background information on the regulatory requirements for data gathering and analysis for environmental restoration

activities, and outlines the data and information management requirements for completing the pre-remediation phases of an environmental restoration project. Information management systems for integrating the regulatory and institutional requirements of the environmental restoration process with the technical data and analysis requirements are also described. 7 refs.

0540 Health and Safety

Refer also to citation(s) 23571, 23572, 23586, 23618, 23793, 24723

23619 (BARC–1458) **Division of Radiological Protection progress report 1982-1988.** Gupta, B.L. (Bhabha Atomic Research Centre, Bombay (India). Div. of Radiological Protection); Bhat, R.M.; Narayan, G.R. (eds.). Bhabha Atomic Research Centre, Bombay (India). 1989. 166p. Order Number DE90621691. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

This report describes the work of the Division of Radiological Protection during 2-88, for implementation of radiation safety in all institutions in the country using radiation sources for medical, industrial and research applications. It gives information about personnel monitoring using photographic film and TLD badges, neutron monitoring badges, dosimetric techniques developed, calibration facilities and maintenance of national standards for radiation and radioactivity, design and fabrication of special radiation protection instruments, development of coloured indicators for indentification of radiation sterilized medical products, advisory and licencing services, regulation and transport of radioactive materials, periodic protection survey, education and training related to radiation safety programmes. About 500 publications by the staff of this Division are listed. (author). 46 figs.

23620 **Population exposure from the nuclear fuel cycle: Proceedings.** Alpen, E.L. (California Univ., Berkeley, CA (USA)); Chester, R.O.; Fisher, D.R. 355p. Gordon and Breach Science Publishers S.A., New York, NY (1988). Sponsored by American Nuclear Society; U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. From ANS/ORNL topical conference on population exposure from the nuclear fuel cycle; Oak Ridge, TN (USA); 14-18 Sep 1987.

The papers in this volume reflect the latest research on the nature and degree of exposure to human populations from ionizing radiation that results from the production of commercial nuclear power. The conference comprised representatives from such notable organizations as Brookhaven National Laboratory, the Inhalation Toxicology Research Institute and Pacific Northwest Laboratories. Issues addressed include the effects on humans of the mining and extraction of uranium and the fabrication of fuel for nuclear reactors, the decommissioning and disposal of facilities that are no longer useful or efficient and the likelihood of major nuclear accidents. Each document will have to be cataloged separately.

23621 (DOE/EH–0108) **Tiger team assessment of the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee.** USDOE, Washington, DC (USA). Feb 1990. 496p. Sponsored by U.S. DOE Environment Health & Safety. Order Number DE90008026. Available from NTIS, PC A21/MF A01 - OSTI.

This document contains findings identified during the Tiger Team Compliance Assessment of the Department of Energy's (DOE's) Y-12 Plant in Oak Ridge, Tennessee. The Y-12 Plant Tiger Team Compliance Assessment is comprehensive in scope. It covers the Environmental, Safety, and Health [including Occupational Safety and Health Administration (OSHA) compliance], and Management areas and determines the plant's compliance with applicable federal (including DOE), state, and local regulations and requirements. 4 figs., 12 tabs.

23622 (DOE/EH–90008880) **Training Accreditation Program: Performance-based training manual: TAP 2.** USDOE Assistant Secretary for Environment, Safety, and Health, Washington, DC (USA). 1 Mar 1989. 220p. Sponsored by U.S. DOE Environment Health & Safety. Order Number DE90008880. Available from NTIS, PC A10/MF A01; OSTI; INIS; GPO Dep.

The cornerstone of safe operation of Department of Energy (DOE) nuclear facilities is personnel performing the day-to-day functions which accomplish the facility mission. Training that is conducted efficiently and effectively and is directly related to the needs of the job (i.e. performance-based training) is fundamental to safe operation. Responsibility for the safe operation of these facilities is a line management function. Therefore, achieving performance-based training requires commitment from the organization for which training is provided. This commitment includes making subject matter experts available for participation in and review of the products of the performance-based training process. It also includes budgeting and scheduling the time required for both initial and continuing training. This commitment must be made by corporate and facility senior management from the beginning. Management must get involved at the start to ensure that they are not only cognizant of ongoing activities, but are also involved to the degree necessary to thoroughly understand the process. Policies implemented and support demonstrated by senior management provide the driving force to ensure that training programs receive the attention that is imperative if facility training programs are to be successful.

23623 (PNL-SA–17282) **Strategies for environmental restoration in an evolving regulatory environment.** Keller, J.F.; Geffen, C.A. Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 11p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. (CONF-900210–32: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90008606. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The US Department of Energy (DOE) is faced with the immense challenge of effectively implementing a program to mitigate and manage the environmental impacts created by past and current operations at its facilities. Such a program must be developed and administered in accordance with the Comprehensive Environmental Response, Compensation and Liability Act and the Resource Conservation and Recovery Act. These regulations are extremely complex, burdening the environmental restoration process with a number of planning and public interaction requirements that must be met before remediation of a site may begin. Existing regulatory and institutional requirements for environmental restoration dictate that extensive planning, characterization and assessment activities be conducted. An important part of the process is the involvement of regulators and the public in the site characterization and assessment activities and in developing reasonable solutions for cleanup. This paper identifies the regulatory requirements and highlights implementation strategies for key aspects of the environmental restoration process for DOE. Trends in legislation and policy relevant to the DOE environmental restoration process are highlighted, with strategies identified for dealing with the evolution of the regulations while maintaining continuity in the technical activities required for cleaning up the DOE hazardous and mixed waste sites. 10 refs.

23624 (PNL-SA–17336) **Inactive waste sites at Hanford: The technical and management challenge.** Gephart, R.E.; Hanson, M.S. Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 26p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. (CONF-900210–31: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90008609. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper examines some of the key technical and management challenges facing the Hanford Site in developing a coordinated and consistent approach to the cleanup of inactive waste sites. These challenges are similar to those of the original Hanford Site selection and the development of nuclear technology some 45 years ago. To help in understanding these challenges, early Hanford Site history, onsite operations, past waste storage/disposal activities,and Hanford's approach to the characterization and cleanup of inactive waste sites are also described. 28 refs., 5 figs.

0550 Safeguards, Inspection, and Accountability

Refer also to citation(s) 23566

23625 (SAND–89-0926/1) **SAVI: Systematic Analysis of Vulnerability to Intrusion: Volume 1.** Sandia National Labs., Albuquerque, NM (USA); Science and Engineering Associates, Inc., Albuquerque, NM (USA). Dec 1989. 357p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90008574. Available from NTIS, PC A16/MF A01 - OSTI; GPO Dep.

SAVI (Systematic Analysis of Vulnerability to Intrusion) is a PC-based software package for modeling and analyzing physical protection systems. SAVI implements several features that make it a unique product. First, the user interface for site modeling and data entry is simple and flexible. Second, the SAVI model analyzes all adversary paths to the target location and, if selected, all exit paths from the target location. Third, a reference catalog and database are included that define the protection elements and safeguards components, and give detection and delay performance values for the components. Finally, SAVI's results are output in graphic form and include recommendations for upgrade.

23626 (SAND–89-0926/2) **SAVI: Systematic Analysis of Vulnerability to Intrusion: Volume 2.** Sandia National Labs., Albuquerque, NM (USA); Science and Engineering Associates, Inc., Albuquerque, NM (USA). Dec 1989. 491p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90008160. Available from NTIS, PC A21/MF A01 - OSTI.

SAVI (Systematic Analysis of Vulnerability to Intrusion) is a PC-based software package for modeling and analyzing physical protection systems. SAVI implements several features that make it a unique product. First, the user interface for site modeling and data entry is simple and flexible. Second, the SAVI model analyzes all adversary paths to the target location and, if selected, all exit paths from the target location. Third, a reference catalog and database are included that define the protection elements and safeguards components, and give detection and delay performance values for the components. Finally, SAVI's results are output in graphic form and include recommendations for upgrade.

23627 (SAND–89-2600) **Modular Integrated Video System: Final report.** Schneider, S.L. Sandia National Labs., Albuquerque, NM (USA). Oct 1989. 86p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90008168. Available from NTIS, PC A05/MF A01 - OSTI.

The Modular Integrated Video System (MIVS) was developed to provide a replacement surveillance system for the IAEA's Twin Minolta Film Camera System. This task was sponsored by the Department of Energy (DOE) and the US Program for Technical Assistance to IAEA Safeguards (POTAS). This is the final report describing the development, testing, and production of the MIVS. It begins with the generation of a Program Plan identifying the principal steps necessary for the development of a highly reliable, quality surveillance system. Among these steps were the generation of the functional specifications and the certification test plan. These documents describe prototype development and demonstration, Class III production, environmental testing, reliability testing, field commissioning, and commercial manufacturer selection. Data accumulated from the various steps of the Program Plan are presented in this final report. 10 figs.

23628 (SAND–89-2690) **Modular Integrated Video System (MIVS) environmental test report.** Schneider, S.L.; Insch, K.W. Sandia National Labs., Albuquerque, NM (USA). Oct 1989. 27p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90008167. Available from NTIS, PC A03/MF A01 - OSTI.

To provide the assurance that a newly developed system meets customer requirements, certification testing of the system must be performed. The MIVS Program Plan required the generation of a Certification Test Plan, detailing the necessary steps required to certify the performance, reliability and quality of the MIVS. This report explains the results of the multi-element environmental testing, of the safety tests performed on the units, and the mechanical shock and random vibrations tests. 3 figs.

23629 (SAND–90-0859C) **Safeguards of special nuclear materials at Los Alamos and Sandia National Laboratories.** Gutierrez, J.A. (Los Alamos National Lab., NM (USA)); Trujillo, M.M. Sandia National Labs., Albuquerque, NM (USA); Los Alamos National Lab., NM (USA). [1990]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789;W-7405-ENG-36. (CONF-900394–3: 1990 national symposium of the Society of Mexican-American Engineers and Scientists (MAES), Albuquerque, NM (USA), 28-31 Mar 1990; LA-UR–90-966). Order Number DE90008805. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

DOE Orders require that all contractors whose mission deals with Special Nuclear Materials (SNM) have a comprehensive program for insuring that SNM is protected from insider and outsider threats. These requirements are met by performing inventories and measurements at specified time intervals depending on the attractiveness of the material. Also, because there are waste streams associated with processing SNM, Sandia National Laboratories and Los Alamos National Laboratory are continually monitoring liquid waste leaving the sites for treatment, etc. We will discuss the procedures that are used for scanning employees who have been treated with radioactive isotopes for medical purposes, and who must work in a Material Access Area. Search techniques for vehicles, personnel and hand carried items will be described. Responses to SNM alarms are addressed in this paper. Security personnel from these facilities are involved in the SNM removal process from the points of ensuring authorized removals are proper and that unauthorized removals do not occur. Special training of these personnel will be described. This paper will serve as an introduction to the youth of our society into a new and fast growing profession. The market for professionals in the area of Security and Safeguards is increasing due to new, more stringent regulations coming from DOE. Specifically, there is a tremendous market for more Hispanics who are well-versed and educated in the area of Security and Nuclear Safeguards.

0560 Legislation and Regulations

Refer also to citation(s) 23587

07 ISOTOPE AND RADIATION SOURCE TECHNOLOGY

0701 Physical Isotope Separation

23630 (UCRL–102814) **Safety and reliability assessment of the EDS [Engineering Demonstration System] Hardwire Interlock System using extended fault trees.** Corynen, G.C. Lawrence Livermore National Lab., CA (USA). Jan 1990. 79p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008150. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

A safety and reliability assessment of the Laser Isotope Separation (LIS) Engineering Demonstration System (EDS) Hardwire Interlock System (HIS) has been completed. A major objective of the assessment was to identify any single-point failures in the HIS that could cause an unacceptable radiological hazard, and this report presents the results of this assessment. We present a brief tutorial review of fault tree methods and summarize a new method for handling closed loop fault structures called extended fault trees. We also outline a new computation procedures called Monitored and Controlled Systems (MCS), which was developed to apply extended fault trees to the HIS.

23631 (ZfK–632) **Production of fission molybdenum by using irradiated natural uranium targets.** Bernhard, G.; Boessert, W.; Hladik, O. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1988. 17p. (In German). Order Number DE90621817. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In this paper a procedure is described for the production of fission molybdenum. The production method is particularly suitable for those, which do not dispose on highly enriched uranium. The aim was to realize a simple technology. Starting from irradiated uranium oxide the following steps are included: dissolution of the target in 6 M nitric acid, separation of ^{99}Mo from uranium and the

bulk of other fission products by adsorption/desorption on alumina and purification of the molybdenum fraction by thermochromatography. The waste treatment is described too. The final product ^{99}Mo is well suited for manufacturing high quality $^{99}Mo/^{99m}Tc$ generators. (author).

0702 Radiation Sources

Refer also to citation(s) 24037, 24039, 24287

23632 (CEA-CONF–9891) **Use of nuclear techniques for measuring thin wears.** Jeanneau, B. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Office des Rayonnements Ionisants. 1989. 7p. (CONF-8905294–: 28. meeting on special steels, Liege (Belgium), 24-25 May 1989). Order Number DE90762044. Available from NTIS (US Sales Only), PC A02/MF A01.

Wear measurements with apparatus of classical metrology like profilography or tridimensional analysis, need a certain number of conditions, in particular, dismantling of the machine into parts, which give less of time and money. Radioactive methods permit to avoid such a dismantling, isn't sensitive to the temperature of the part... and according to their sensitivity, reduce the test duration.

23633 (IAEA-TECDOC–537, pp. 27-45) **On-line measurements of bulk coal using prompt gamma neutron activation analysis.** Marshall, J.H. III (MDH-Motherwell Inc., Monrovia, CA (USA)); Zumberge, J.F. International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8901184–: Advisory group on prompt gamma neutron activation analysis in borehole logging and industrial process control, Vienna (Austria), 30 Jan - 3 feb 1989). In *Prompt gamma neutron activation analysis in borehole logging and industrial process control: Report of an advisory group meeting held in Vienna, 30 January - 3 February 1989.* Order Number DE90621001. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

The application of Prompt Gamma Neutron Activation Analysis to on-line measurements of coal quality is described. Neutrons from ^{252}Cf are thermalized and captured by coal nuclei, and the resulting prompt gamma radiation is detected in a large NaI scintillation crystal. The measured gamma-ray energy spectrum is interpreted through microprocessor-based signal processing to determine the amounts of the major elements in coal together with other useful quantities that can be derived from elemental composition. Measurements with a prototype instrument compare very favorably with conventional laboratory analysis. (author). 15 figs.

0703 Isotopic Power Supplies

Refer also to citation(s) 23872

08 HYDROGEN

Refer also to citation(s) 23980

0801 Production

Refer also to citation(s) 23300, 23304

23634 (DOE/METC–88/6092-Vol.2, pp. 415-424) **Gas separation using ion exchange membranes for producing hydrogen from synthesis gas.** Pellegrino, J.J. (National Bureau of Standards, Boulder, CO (USA)); Nassimbene, R.; Kirkkopru, A.; Noble, R.D.; Way, J.D. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The overall goal of this program is to demonstrate the use of facilities transport membranes in the production of hydrogen from synthesis gas. The objectives include: evaluating candidate membranes, carriers, solvents, treatments and the effects of process conditions for facilitated transport separation of CO_2, CO, H_2S and H_2; and developing mathematical models to guide experimental work and interpretation of results and to aid in process design and optimization of a membrane-based separation scheme for producing H_2 from coal. Results from permeability tests on several types of polyperfluorosulfonic acid and polybenzimidizole membranes are presented. A pretreatment procedure is described which increases permeability 4-6 fold.

23635 (DOE/METC–88/6092-Vol.2, pp. 425-433) **Low cost hydrogen/novel membrane technology for hydrogen separation from synthesis gas.** Baker, R. (Membrane Technology and Research, Inc., Menlo Park, CA (USA)); Bell, C.M.; Wijmans, H.; Gottschlich, D.; Roberts, D. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The separation of hydrogen from synthesis gas is a major cost element in the manufacture of hydrogen from coal. Separation of these gases by membranes is an alternative technique that is still largely unexplored and that could offer substantial cost savings. The objective of this program is to develop membranes suitable for these separations and demonstrate their applicability with small spiral-wound modules on model gas mixtures representative of those found in synthesis gas processes. The performance data thus obtained will be used in a mathematical model to evaluate the performance and the economics of an entire process. Based on this initial screening, two polymers were selected for membrane development work: Poly(etherimide) for the separation of hydrogen from nitrogen and from carbon monoxide; and Poly(ether-ester-amide) for the separation of hydrogen sulfide and carbon dioxide from hydrogen. Results are discussed for both these membranes, the spiral-wound modules, and the computer model and economic evaluation.

23636 (DOE/METC–88/6092-Vol.2, pp. 444-452) **A novel approach to hydrogen recovery, storage and transport.** Fowler, M.C. (United Technologies Research Center, East Hartford, CT (USA)). USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The objective of the current program is the demonstration of liquid organic hydride extraction of hydrogen from a mixed gas stream. Hydrogenation studies will identify contaminant resistant catalysts for the extraction reaction, and dehydrogenation studies will confirm effective catalysts for the recovery reaction. Using the catalysts thus defined, a laboratory scale sequential recovery reactor system will be fabricated and operated with typical gas mixtures to demonstrate experimentally the organic hydride recovery, storage and transport of hydrogen. The paper describes the following accomplishments to date: (1) test apparatus and procedures (flow control and reactant mixing, catalytic reactor, product collection, and measurement of the extent of reaction); (2) catalysts (platinum/rhenium for baseline catalyst, nickel, and cobalt/molybdenum); (3) hydrogenation measurements with the Pt/Re catalyst (toluene hydrogenation with and without contaminants present).

23637 (DOE/METC–88/6092-Vol.2, pp. 463-473) **Hydrogen recovery by novel solvent systems.** Shinnar, R. (The Research Foundation of C.U.N.Y., New York, NY (USA)); Ludmer, Z. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The objective of this work is to develop a novel method for purification of hydrogen from coal-derived synthesis gas. The study involves the search for suitable mixtures of solvents for their ability to separate hydrogen from the coal derived gas stream in significant concentration near their critical point of miscibility. The

properties of solvent pairs identified will be investigated in more detail to provide data necessary for economic evaluation and process development. This paper discusses selectivity/theoretical considerations and describes the design and construction of the test facility and the preliminary screening of solvent pairs.

23638 (DOE/METC–88/6092-Vol.2, pp. 474-483) **Low temperature, sulfur tolerant, homogeneous catalysts for the water-gas shift reaction.** Wilson, R.B. Jr. (SRI International, Menlo Park, CA (USA)); Wood, B.J.; Crawford, E.J.; Asaro, M.F.; McCarty, J.G.; Schwaar, R.H. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The objective of this project is to identify, prepare, test, characterize, and evaluate a practical, homogeneous catalyst for the production of hydrogen from coal gas by the water-gas shift reaction (WGSR). Seventeen catalyst systems have been examined for water-gas shift reaction activity. These catalysts included carbonyl complexes based on Cr, Fe, Mo, Rh, Ru, and W, dispersed in protic and aprotic solvents, and activated by a variety of bases. The tri-ruthenium dodecacarbonyl complex has exhibited superior performance among the tested catalysts. Best results to date were obtained with tetramethylhexanediamine as the base and triglyme as the solvent. This system exhibited a turnover frequency (TF) of 53 (mol product/mol catalyst/h) at 180 C. The initial activity of the $Ru_3(CO)_{12}$/amine catalyst system remained nearly constant in successive recharges of the batch reaction vessel with fresh reactant. These results suggest that, in a continuous flow system, conversion will remain high over extended periods of operation. The initial activity of the $Mo(CO)_5$/alkali base in protic solvents is somewhat lower than that of the ruthenium catalyst but also remains constant upon successive recharges of reactant. Sulfur contaminant in the feedstock at a level equivalent to 1000 ppm H_2S had little effect on the performance of most of the tested catalyst systems. Initial tests in a continuous flow/semibatch reactor of the $Mo(CO)_5$/alkali base/protic solvent catalyst demonstrated activities similar to that observed in batch reactions. A preliminary technoeconomic analysis that compared homogeneous and heterogeneous WGSR processes, indicated that the homogeneous catalyst technology could be competitive.

23639 (DOE/METC–88/6092-Vol.2, pp. 494-503) **Production of hydrogen from low-rank coal.** Sears, R.E. (Univ. of North Dakota, Grand Forks (USA)); Timpe, R.C. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The objective of this research is to evaluate the technical feasibility of producing low-cost hydrogen by catalytic steam gasification of low-rank coals. A Major portion of this research program includes the design, construction, and testing of a 6-inch diameter fluid-bed system to determine the optimum operating conditions for producing low-cost hydrogen from coal. Data collected from this process development work will be used to develop preliminary design data for scale-up of the process. A systems approach of the technology and an assessment of the process economics will be developed based on the end-use applications, pilot-scale performance data, and downstream processing. Coal reactivity will be correlated with identified coal properties to help elucidate the mechanism for catalytic steam gasification to produce hydrogen as part of the laboratory study running concurrently with the process development work. Reactivities of coal chars computed on both a weight basis and an active site basis will be determined using TGA. Instrumental analysis to be performed on each coal, char and ash that are derived from reactivity studies will include solid ^{13}C NMR, x-ray diffraction, x-ray fluorescence, and Electron Spectroscopy for Chemical Analysis (ESCA) and Scanning Electron Microscopy (SEM) surface analysis. Results from both the process development unit and the study of coal properties and reactivity are discussed.

0802 Storage, Transport, and Handling

Refer also to citation(s) 23636

09 BIOMASS FUELS

23640 (DOE/CH/10093–68) **Biofuels program summary: Volume 1, Overview, Fiscal year 1989.** Solar Energy Research Inst., Golden, CO (USA). Jan 1990. 20p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE89009483. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Biofuels–solid, liquid, and gaseous fuels derived from plant materials and wastes–are not a new source of energy for our nation. More correctly, they are an underused source. In 1989, biofuels contributed approximately 3.4 quads (one quad equals 10^{15} Btu) to our national energy mix, or about 3.8% of US total annual energy consumption. Experts estimate that this resource has the potential to provide 15%-20% of our nation's total energy by 2000, a three- to fourfold increase over today's consumption. The primary benefit will be in the transportation sector, which currently consumes more than 65% of the nation's total oil and gas supplies, imported and domestic. Liquid biofuels promise to reduce our nation's reliance on oil imports, improve energy security, reduce greenhouse gases from automotive emissions, and give American farmers alternative crop options. 21 figs.

0908 Production

23641 **Plant transposable elements.** Basic Life Sciences, Volume 47. Nelson, O. (ed.) (Council for Research Planning in Biological Sciences, Inc., Washington, DC (USA)). 389p. Pluenum Press Press, New York, NY ([1988]). Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER13706. From International symposium on plant transposable elements; Madison, WI (USA); 22-26 Aug 1987.

This document presents 27 publications from a symposium on the transposable portions of various plant genomes. Topics include gene regulation, genetic analysis, recombinant technology, mutator functions, gene tagging, extrachromosomal elements, and gene activation in common laboratory plants like tobacco, maize, and alfalfa. Individual papers were processed separately for the data base. (TEM)

23642 (NEI-DK–265) **Methane from food wastes and other organic wastes: Aalborg borough.** Nellemann (N.) og Partnere A/S, Aalborg (Denmark). May 1989. 73p. (In Danish). Order Number DE90760214. Available from NTIS (US Sales Only), PC A04/MF A01.

Prepared for Aalborg kommune, Magistratens 5. afdeling, Teknisk Sekretariat.

Description of various methods for management of organic wastes (including food wastes) from Aalborg borough, in relation to biomass conversion plants. Emphasis is laid on technological and economical aspects. It is considered important that the organic wastes from industry and from households are sorted at the source. After gasification the biomass can be mixed with manure and used as a fertiliser. (AB).

23643 (NEI-DK–280) **Study of mechanized multiple tree felling, dragin, deneedling and chipping: Experiment description and results.** Suadicani, K. Skovteknisk inst., Copenhagen (Denmark). Dec 1989. 16p. (In Danish). Contract EM-1383/88-7. Order Number DE90760234. Available from NTIS (US Sales Only), PC A03/MF A01.

EFP-88.

A time study for mechanized tree felling, drag in, deneedling and chipping of contorta fir trees is presented in additon to a frequency study of the deneedling and chipping processes. The project was carried out in a 35 year old contorta fir plantation. The tree felling was a mechanical process, and the whole trees were dragged to

the dennedler and the chipper which were stationary. During one working hour 290 trees were felled and 190 were dragged in over 200 meters. It is suggested that by using a dragging tractor with a more power ful motor on which was attached a larger crane and clamping jaw, and which did not have to clear up in front of the chipper, 290 trees could be dragged in per hour. The deneedler and the chipper worked through 180 trees per hour. This number could be increased to about 270 trees if the removal of twigs in front of the deneedler could be carried out with the help of a conveyer belt and if the dennedler had a longer and more powerful crane that was adequately steadied. If these conditions are taken into consideration the cost estimation is 60-70 Danish crowns per cubic meter chips delivered by road. (AB).

23644 (NEI-DK–292) **Anaerobic digestion of wastes: Status and plans.** Olsen, N. (Hvidovre Kommune (Denmark)). Amagerforbraending I/S, Copenhagen (Denmark). Jun 1989. 51p. (In Danish). Order Number DE90760254. Available from NTIS (US Sales Only), PC A04/MF A01.

A study also based on a survey of relevant Danish and foreign literature, of the feasibility of utilizing organic municiple wastes in biomass conversion plants for the production of methane. The collection and sorting of organic wastes are discussed in detail as is also the design of a biomass conversion plant. (AB).

0909 Processing

Refer also to citation(s) 23644

23645 (AFME–87-92-0012) **Biomass upgrading. New R and D programs in Japan.** Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). Nov 1987. 94p. (In French). Order Number DE90761951. Available from NTIS (US Sales Only), PC A05/MF A01.

A review of the Research and Development programs and trends concerning biomass upgrading in Japan (except food industry and pulp and paper industry) is presented: review of the biotechnology programs in Japan and its policy, presentation of the Human Frontier Science Program (sensory perception, genetics, morphogenesis, molecular recognition, energy conversion), presentation of the Biojapan 87 exhibition, fatty substances up-grading, sugars upgrading, wood and derivatives up-grading (with plastic additives).

23646 (DOE/ER/13543–4) **Soybean ribulose bisphosphate carboxylase small subunit: Mechanisms and determinants of RNA turnover in higher plants: Progress report, 1989–1990.** Meagher, R.B. Georgia Univ., Athens, GA (USA). Research Foundation. Feb 1990. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG09-86ER13543. Order Number DE90008833. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The goals of examining the mechanisms and determinants of RNA turnover in higher plants remain the same. We will continue with two of the major approaches (1) in vivo chemical modification of RNA structure and (2) analysis of Rubisco SSU RNA structure and turnover in transgenic plants. We plan to reduce the amount of molecular physiology (studies of transcription and steady state levels) to a minimum and expand these efforts into the analysis of plant rebonucleases. We have also broadened our examination of light induced turnover of rubisco SSU RNA to include general RNA turnover. We plan to identify specific 3′->5′ precessive ribonuclease by complementation of E. coli mutants. The activity of these novel RNases and their potential role in plant RNA turnover and processing will be characterized.

23647 (DOE/ER/13690–2) **[Characterization of lignin peroxidases from Phanerochaete: Annual report].** Pennsylvania State Univ., University Park, PA (USA). [1989]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER13690. Order Number DE90008644. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Our studies on molecular biology have unequivocally demonstrated that the lignin peroxidases are coded for by different genes. We are to first to report on the cloning and structure of a cDNA clone encoding lignin peroxidase isozyme H8. Consistent with the classification of ligninase as a peroxidase, certain residues thought to be essential for peroxidase activity were identified. The amino acid sequences near these residues are homologous with other known peroxidase sequences. Our cDNA clone has also allowed us to show that expression of ligninases is regulated at the level of messenger RNA production. More recently, we have isolated cDNAs encoding lignin peroxidase isozymes H2, H6, and a variant H8. Comparative Northern blotting analyses of RNA isolated from basidoiospores have shown that these cDNA clones are not allelic variants, but are encoded by distinct genes. Our cloning studies have also demonstrated that the lignin peroxidase genes are not coordinatedly regulated in response to environmental stress. For example, our Northern blot results and protein work has shown that under conditions of nitrogen limitation, both the H2 and H8 isozymes are expressed, whereas under carbon limitation only isozyme H2 is expressed. Under both nitrogen and carbon limitation the regulation occurs at the level of mRNA production.

23648 (NEI-DK–262) **Communal biogas plants: Agriculture, environment, energy, industry. Halfway report from the coordination committee for communal biogas plants.** Energistyrelsen, Copenhagen (Denmark). Jun 1989. 93p. (In Danish). Order Number DE90760182. Available from NTIS (US Sales Only), PC A05/MF A01.

The Danish Minister of Energy, in consultation with the Minister of Agriculture and the Minister of the Environment, established a Cordination Committee in relation to communal biomass conversion plants in 1986. The aim was to produce a plan of action that could draw attention to potentials for these plants in Denmark, concentrating on agricultural, environmental, industrial, energy and export aspects mentioned above and discusses future development. (AB) 22 refs.

23649 (NEI-DK–263) **Thermophilous biogas production based on animal manures.** Petersen, S.P.; Johansen, K.; Noergaard, P.; Petersen, G.H.; Spendler, F.H.; Tafdrup, S. Koordineringsudvalget for Biogasfaellesanlaeg (Denmark). Apr 1989. 80p. (In Danish). Order Number DE90760183. Available from NTIS (US Sales Only), PC A05/MF A01.

Digestion of animal manures at a thermophilous temperature (50-60 deg. C) presents good potentials in relation to the speedy and effective conversion of biomass to energy, sterilisation of manure and the redistribution of the decontaminated material in the fields. Yet lack of experimentation with this method has lead to a certain scepsis and hesitation regarding its utilization. A survey of current knowledge in this area, and a description of laboratory and field experiments, are presented. It is concluded that the thermophilous digestion functions satisfactorily when using certain types of animal manures and could be improved by mixing them with other materials that are easily digested. (AB).

23650 (NEI-DK–281) **Final report on biomass conversion plants and dual-purpose power plants.** Toender Tekniske Skole (Denmark). [1989]. 15p. (In Danish). Contract TR-87.645. Order Number DE90760235. Available from NTIS (US Sales Only), PC A03/MF A01.

A demonstration project carried out in relation to the curriculum for agricultural students at Toender Agricultural School in Denmark. Included in the system is a 50 m2 biomass conversion plant using manures and a 45 kWe cogenration plant. Methane produced by the biomass conversion plant is lead to, and used as fuel for, the cogeneration plant which consists of a 6 cylinder engine with a generator. This produces electric power and the waste heat is used for heating the school building. The methane fuel is supplemented with natural gas. Surplus electric power is lead to the local network. The establishment and operation of this combined system is described. (AB).

23651 (PIRSEM–3256) **Spore production in solid medium and implementation in bioconversion processes.** Gros, J.B.; Larroche, J.B. Centre National de la Recherche Scientifique, 75 - Paris (France). Programme Interdisciplinaire de Recherche sur les Sciences pour l'Energie et les Matiernes Premieres (PRISEM). 1988. 92p. (In French). Order Number DE90761950. Available from NTIS (US Sales Only), PC A05/MF A01.

The sporulation of Penicillum roqueforti on buck'wheat seeds is studied: many spores are situated in the seeds. In order to prevent this inconvenience, it was suggested to use porous inert substrates, impregnated with the nutrient medium. Alginate spherules

are used. In the second part of the study, the behavior of P. roqueforti spores on buckwheat seeds during a bioconversion reaction, the synthesis of heptanon-2 from octanoic acid, is studied.

23652 (SERI/SP–220-3548) **Sourcebook of methods of analysis for biomass and biomass-conversion processes.** Milne, T.A.; Brennan, A.H.; Glenn, B.H. Solar Energy Research Inst., Golden, CO (USA). Feb 1990. 371p. Sponsored by U.S. DOE Conservation & Renewable Energy; International Energy Agency; Solar Energy Research Institute. DOE Contract AC02-83CH10093. Order Number DE89009494. Available from NTIS, PC A16/MF A01 - OSTI; GPO Dep.

Since the oil embargo of the 1970s, researchers around the world have made tremendous progress in developing and improving methods for converting biomass – trees, plants, and organic wastes – to useful fuels and chemicals. However, the lack of relevant standards and analytical methods has made comparison of results between laboratories and nations difficult. This Sourcebook of Methods of Analysis for Biomass and Biomass-Conversion Processes is the result of an international effort to begin to fill this gap. In 1986, the International Energy Agency began sponsorship of a "Voluntary Standards Activity," designed to provide comparability of research results, increase research efficiency, and provide quality assurance to both researchers and industry. Canada, Finland, New Zealand, and the United States supported the activity initially; Italy joined in 1988. Major support also came from Energy, Mines and Resources Canada (E,M&R); the US Department of Energy's Solar Technical Information Program (STIP); and the Solar Energy Research Institute (SERI). The sourcebook presents titles and abstracts (when available) of methods relevant to all aspects of biomass conversion – from analyzing feedstocks to evaluating performance of biofuels. The authors assembled the sourcebook at SERI by searching the literature, reviewing industrial standards, and soliciting suggestions from scientists in the field. In addition, Finland prepared a special report on measuring the efficiencies of small boilers and biomass stoves and furnaces.

23653 **Methanol synthesis catalysts based on Cs/Cu/ZnO/M_2O_3 (M = Al, Cr, Ga): Genesis from coprecipitated hydrotalcite-like precursors, solid-state chemistry, morphology, and stability.** Nunan, J.G. (Lehigh Univ., Bethlehem, PA (USA)); Himelfarb, P.B.; Herman, R.G.; Klier, K.; Bogdan, C.E.; Simmons, G.W. *Inorganic Chemistry (USA)*, 28(20): 3868-3874 (4 Oct 1989). DOE Contract AC22-84PC70021.

The formation, decomposition, and reconstitution of hydrotalcite-like hydroxy carbonates $(Cu_{0.4}Zn_{0.6})_6M_2(OH)_{16}CO_3 \cdot 4H_2O$ (M = Al, Cr, Ga) have been studied to determine the causes of the high long-lasting catalytic activity (M = Cr) and the severe deactivation (M = Al, Ga) of the $Cu/ZnO/M_2O_3$ method synthesis catalysts doped with cesium after thermal decomposition of the hydrotalcite-like precursors. The alumina-based (M = Al) and gallia-based (M = Ga), but not the chromia-based (M = Cr), $CuO/ZnO/M_2O_3$ mixed oxides that were produced by thermal treatment at 623 K of the hydrotalcite-like compounds reconstituted the original hydrotalcite-type compounds during the aqueous doping procedure carried out with the cesium formate promoter, CsOOCH. The re-formation of the Al- and Ga-containing catalysts to their hydrotalcite-like precursors is due to incomplete decomposition of the hydroxy carbonates prior to doping. Electron diffraction and transmission electron microscopy give evidence for the reconstitution reactions. The alkali-metal-promoted methanol synthesis catalyst of choice from hydrotalcite-type precursors is based on chromia. 27 refs., 13 figs., 4 tabs.

0910 Properties and Composition

Refer also to citation(s) 23652

0930 Economic, Industrial, and Business Aspects

Refer also to citation(s) 23652, 23893

23654 (NEI-DK–275) **Energy from biomass: Perspectives and potentials for expedient utilization as a renewable energy source.** Sirkin, T. Dansk Brandvaerns-Komite, Birkeroed (Denmark). Nov 1989. 129p. (In Danish). Order Number DE90760228. Available from NTIS (US Sales Only), PC A07/MF A01.

A description of the potentials of biomass as an energy source in Denmark. Political, ecological and ethical aspects, and research results, are discussed and possibilities for development in this area pointed out. The significance of biomass as a nutrient form of animal feed and as a fertilizer is explained, and it is suggested that when considering methods of conversion to fuel this should be taken into considering. The idea that fuel from biomass conversion could be used in the transport sector and for the production of electric power is presented and the importance of involving nutrient waste products of biomass conversion in the ecological system is stressed. (AB) 121 refs.

0970 Legislation and Regulations

Refer also to citation(s) 23654

0980 Waste Management

23655 (AFME–87-01-0037) **Study of the Biopresse process introduction in a waste incineration line.** Pascual, C.; Beroud, M. Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). 1988. 49p. (In French). Order Number DE90761946. Available from NTIS (US Sales Only), PC A03/MF A01.

The Biopresse process is a machine which allows the rapid separation of the fluid and solid components of a municipal waste mixture, and results in the production of two by-products, an organic fertilizer (water and fermentable organic matters) and the fuel (or dry matters) composed of papers, packaging elements and metallic parts. The pressing direction is perpendicular to the compression chamber axis in order that the grid holes are not clogged. The overall design of the incineration line is described and the performances analyzed.

10 SYNTHETIC FUELS

1002 Production

Refer also to citation(s) 23266

1004 Combustion

Refer also to citation(s) 23892

13 HYDRO ENERGY

1301 Resources and Availability

23656 (AFME–85-09-1169) **Inventory of the small power station sites in Morocco, for connection with the national network.** Anon. Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). 1988. 100p. (In French). Order Number DE90761949. Available from NTIS (US Sales Only), PC A05/MF A01.

The first part of this study is concerned with an identification of the hydroelectric potential for small power stations from the irrigation network in Morocco. Very few potential sites were found; four sites are studied precisely (from 170 kw to 3900 kw). In the second part, a rural electrification program in five valleys of the Atlas is studied: evaluation of the electricity demand, design of the production stations (adapted to the local irrigation network) and economical analysis of the program.

1303 Plant Design and Operation

Refer also to citation(s) 23656

23657 (DOE/ID/12356–T1) **Report on siphon penstocks for hydroelectric projects.** Acres International Corp., Amherst, NY

(USA). Feb 1989. 249p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC07-82ID12356. Order Number DE90008613. Available from NTIS, PC A13/MF A01 - OSTI; GPO Dep.

This report on the use of siphon penstocks for hydroelectric installations has been prepared under DOE Contract AC07-82ID12356 by Acres International Corporation and draws extensively on the information and data assembled by the following organizations: CHI Engineering Services; Clearwater Hydro; Gannett Fleming Water Resources Engineers, Inc.; Harza Engineering Company; J. Kenneth Fraser and Associates, P.C.; Mead and Hunt, Inc.; TKO Power–Ott Water Engineers, Inc.; and Williams and Broome, Inc. The purpose of the study was to review the design, construction, operation, and maintenance considerations for siphon penstocks. The discussions, data, and information presented are based on experiences with the following operational siphon penstock plants: Columbia Mills Hydroelectric Plant, Virginia; Jim Falls Minimum Flow Unit Hydro Development, Wisconsin; Lac Courte Oreilles Hydro Development, Wisconsin; Ontelaunee Hydroelectric Project, Pennsylvania; Pine Grove Dam Hydroelectric Station, Pennsylvania; Pocono Lake Hydroelectric Project, Pennsylvania; Schaads Reservoir Hydroelectric Project, California; Second Broad River Hydroelectric Project, North Carolina; Superior Dam Power Station, Michigan; Tierckenkill Falls Hydroelectric Project, New York; and Traicao Hydroelectric Project, Brazil. 71 figs., 12 tabs.

23658 (PB–90-137001/XAB) **Optimal operation of the Salt River Project, Arizona. Technical report.** Hooper, E.R.; Lettenmaier, D.P. Washington Univ., Seattle, WA (USA). Dept. of Civil Engineering. Apr 1989. 96p. (WATER-RESOURCES-SER/TR–115). Available from NTIS, PC A05/MF A01.

Extended linear quadratic Gaussian (ELQG) control, a nonlinear stochastic control method for the optimization of the operation of multiple reservoirs with multiple objectives, was applied to the Salt River Project (SRP) reservoir system. The optimization problem was posed as the maximization of total hydropower avoided subject to constraints, where the constraints included both physical constraints (maximum and minimum storage) and water supply objectives. The total hydropower avoided cost accounted for both hydropower generated by the system, and groundwater pumping cost, both of which varied seasonally. The energy generation avoided cost accounted for the net effect of hydropower generated by the reservoir system on the composite SRP generation system, and effectively represented the cost of power that would have to be generated from other sources absent the net hydropower generated by the reservoir system.

1306 Environmental Aspects

23659 (DOE/BP/13381–4, pp. 46, Paper 2) **Development of Chinook salmon fry outplanting strategies for supplementation of depressed stocks and evaluation of the Johnson Creek Fish Passage improvement projects.** Welsh, T.L. (Thomas L. Welsh Bioconsultants, Boise, ID (USA)). Idaho Dept. of Fish and Game, Boise, ID (USA); USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Fish and Wildlife. Apr 1988. In *Idaho habitat evaluation for off-site mitigation record. Annual report, 1987.* Order Number DE90004330. Available from NTIS, PC A12/MF A01.

Summer chinook salmon fry were stocked in upper Johnson Creek drainage during three years, 1985-1987. The number of salmon fry stocked during the three years was 20,000, 186,000 and 105,000 respectively. Snorkel counts and electrofishing collections revealed that brook trout comprised over 96% of the standing fish crop in the upper Johnson Creek drainage prior to the first stocking of salmon fry on August 2, 1985. After three years of chinook salmon fry introductions, brook trout comprised only 10% of the standing crop in the upper Johnson Creek drainage study site. Over 3,200 brook trout were relocated during the three field seasons. Salmon fry production was compared in the brook trout reduction (treatment) sites and adjacent control sites. More salmon fry reared in the control sites than in the treatment sites in eight out of nine replicates. Densities of salmon fry stocked vis helicopter in early May of 1986 and 1987, remained high at the stocking sites. Fry moved up and downstream 2-3 km during the summer and fall growth period and densities diminished sequentially according to distance. Salmon fry were stocked at geometrically progressive increases from 0.3 to 4.8 fry/m square. Rearing densities were positively correlated with stocking densities. Salmon fry growth was negatively correlated with the combined densities of salmon fry and brook trout and percent sand in the substrate. Predation by brook trout on salmon fry was insignificant. Common mergansers preyed heavily on salmon and brook trout in two of the three study streams during 1987. Surviving fish remained concealed in mats of vegetation and undercut banks. At the upper helicopter stocking site in Tyndall Meadows, salmon fry survival was estimated at 14.5% in June of 1987, and 9.0% in August of 1987. Upper Johnson Creek drainage should be stocked with salmon fry at the rate of 0.4 to 1.0 salmon/m square. 16 refs., 17 figs., 3 tabs.

23660 (DOE/BP/13381–4, pp. 55, Paper 3) **A comparison of sediment monitoring techniques of potential use in sediment/fish population relationships.** Torquemada, R.J. (Dept. of Agriculture, Boise, ID (USA)); Platts, W.S. Idaho Dept. of Fish and Game, Boise, ID (USA); USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Fish and Wildlife. Apr 1988. In *Idaho habitat evaluation for off-site mitigation record. Annual report, 1987.* Order Number DE90004330. Available from NTIS, PC A12/MF A01.

This study was designed to improve our ability to quantitatively and qualitatively measure stream bottom substrate. This study will also evaluate several habitat measurements with potential for evaluating fish-sediment response. Large accelerated increases in sediment loads delivered to streams can create intolerable changes within the stream channel and in turn be detrimental to salmonid spawning and rearing. Problems confound the analysis of stream response to increased or decreased sediment loads, however, and especially how this relates to fish populations. Most of the information being used by biologists comes from the results of laboratory analysis, which may not relate to actual stream conditions. Other basic difficulties occur in establishing criteria for measuring fish response. This study was conducted to evaluate several commonly used measurement techniques, attempting to determine the observer bias and variables that relate to or predict fish response. This report outlines the study areas, design, and procedures used to determine which variables are the most representative for predicting the response of fish populations to sediment. The precision and accuracy of these variables and relationships among the variables are assessed. 25 refs., 17 figs., 8 tabs.

23661 (DOE/BP/13381–4, pp. 29, Paper 4) **Intensive evaluation and monitoring of Chinook Salmon and Steelhead Trout production, Crooked River and Upper Salmon River sites.** Kiefer, R.B.; Apperson, K.A. Idaho Dept. of Fish and Game, Boise, ID (USA); USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Fish and Wildlife. Apr 1988. In *Idaho habitat evaluation for off-site mitigation record. Annual report, 1987.* Order Number DE90004330. Available from NTIS, PC A12/MF A01.

The objective of this project is to quantify changes in physical habitat and in chinook salmon and steelhead trout smolt production relating to Bonneville Power Administration (BPA) funded habitat improvement projects. Habitat improvement projects can generally lead to increased fish production, and in anadromous populations the change in smolt production would be the best measure of a project's effectiveness. The actual increase in smolt production, however, has never been statistically quantified in the field. A realistic quantitative approach for Idaho is: (I) to estimate parr production attributable to habitat projects through general monitoring; (2) to quantify relationships between spawning escapement, parr production, and smolt production through intensive monitoring in two typical anadromous stream reaches; and (3) to use the determined parr-to-smolt survival rates as a basis for BPA mitigation accounting. The primary objectives are: (I) to determine smolt production from two typical anadromous streams reaches; (2) to develop parr-to-smolt survival rates for wild and natural salmon and steelhead for BPA habitat project mitigation; (3) to determine the mathematical relationship between spawning escapement, parr production, and smolt production; (4) to determine migration characteristics; (5) to determine the most effective methods of supplementing natural anadromous fish production with hatchery production: (6) to determine habitat rearing potential, potential smolt production, and reproductive potential for the two study

streams; and (7) to determine which factors limit wild and natural smolt production. The upper Salmon River study site is located upstream from the Sawtooth Hatchery at elevations above 1,980 m, with study sections located throughout the upper basin. Materials, methods, and techniques used are discussed. 18 refs., 5 figs., 4 tabs.

23662 (DOE/BP/13381–4, pp. 14, Paper 5) **Johnson Creek Passage Barrier removal.** Holubetz, T.B.; Petrosky, C.E. Idaho Dept. of Fish and Game, Boise, ID (USA); USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Fish and Wildlife. Apr 1988. In *Idaho habitat evaluation for off-site mitigation record. Annual report, 1987.* Order Number DE90004330. Available from NTIS, PC A12/MF A01.

The Columbia River Basin Fish and Wildlife Program, Section 703(c) ,calls for enhancement of salmon habitat by modifying natural impediments to migration in the South Fork Salmon River and tributaries. In 1983, Idaho Department of Fish and Game (IDFG) identified the natural barriers in Johnson Creek down stream from Landmark as being one of the most effective habitat enhancement measures in Idaho. Johnson Creek supports runs of summer steelhead and summer chinook. Adult steelhead apparently could pass these barriers during most flows, but the upper basin produced few juvenile steelhead. Adult chinook were blocked from the upper drainage during low flows of late summer. In most years, chinook spawning and rearing were restricted to the lower end of Johnson Creek. Resident salmonids of Johnson Creek include rainbow trout, bull trout, brook trout, and mountain whitefish and cutthroat trout. Brook trout dominated the fish community in the upper meadow. Livestock grazing has degraded riparian habitat and sedimentation is high in parts of the upper basin. Objectives of the Bonneville Power Administration-funded project in Johnson Creek were to: (1) modify the natural barriers to allow passage by adult chinook into the upper basin, (2) establish summer chinook in habitat made available by the barrier removal project, (3) improve passage conditions for wild steelhead: and (4) increase natural production of anadromous fish consistent with IDFG (1985) Anadromous Fish Management Plan for Sub basin SA-3. Four natural rock barriers were located in the stream. Selective drilling, blasting and removal of individual rocks created lower overpours, jumping pools, and escape avenues. A total of 68 stream kilometers and 436,000 m^2 of rearing habitat was made accessible to summer chinook above the barriers. 2 refs., 6 figs., 2 tabs.

23663 (DOE/BP/13381–4, pp. 10, Paper 6) **Boulder Creek Passage Barrier removal.** Holubetz, T.B.; Petrosky, C.E. Idaho Dept. of Fish and Game, Boise, ID (USA); USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Fish and Wildlife. Apr 1988. In *Idaho habitat evaluation for off-site mitigation record. Annual report, 1987.* Order Number DE90004330. Available from NTIS, PC A12/MF A01.

The Columbia River Basin Fish and Wildlife Program, Section 703(c), calls for enhancement of salmon habitat by modifying natural impediments to migration in the Little Salmon River and tributaries. In 1983, Idaho Department of Fish and Game (IDFG) identified the natural barrier in Boulder Creek as being one of most effective habitat enhancement measures in Idaho. Boulder Creek is located on the West side of the Little Salmon River and enters the river at kilometer 29 (figure 1). Objectives of the project are to: (1) provide assured access for chinook to the upper 20 km of Boulder Creek, (2) introduce spring Chinook of suitable stock above the barriers, and (3) increase natural production of chinook consistent with IDFG (1985) Anadromous Fish Management plan for Sub basin SA-1. Some degradation of the watershed has occurred from logging and roading. Despite the habitat problems, Boulder Creek has good potential for salmon and steelhead rearing. With modification of the waterfall to allow upstream passage of adult salmon in every year, the upper portion of the drainage should contribute significant increases in the chinook salmon production. Chinook fry will be stocked over the next several years to establish the population of chinook salmon above the barrier. In June of 1985, several salmon were observed making repeated unsuccessful attempts at ascending the waterfall. A Bonneville Power Administration -funded project was implemented in the late summer of 1985 to modify the falls to allow passage of adult chinook under all flow conditions. This IDFG project used explosives to lower the height of the falls by removing portions of the solid granite sill to provide a stair stepping of two drops of about 1.2 to 1.54 m, with adequate jumping pools below each drop. The number of fry and eyed eggs stocked and the estimated number of parr produced are provided in Table 2. 2 refs., 2 figs., 2 tabs.

23664 (DOE/BP/13381–4, pp. 105, Paper 1) **Idaho habitat evaluation for off-site mitigation record.** Petrosky, C.E.; Holubetz, T.B. Idaho Dept. of Fish and Game, Boise, ID (USA); USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Fish and Wildlife. Apr 1988. In *Idaho habitat evaluation for off-site mitigation record. Annual report, 1987.* Order Number DE90004330. Available from NTIS, PC A12/MF A01.

The Idaho Department of Fish and Game (IDFG) has been conducting an evaluation of proposed and existing habitat improvement projects for steelhead and chinook salmon in the Clearwater River and Salmon River drainages over the last four years. Projects included in the evaluation are funded by or proposed for funding by the Bonneville Power Administration (BPA) under the Northwest Power Planning Act as off-site mitigation for downstream hydropower development on the Snake and Columbia rivers. This evaluation project is also funded under the same authority. A mitigation record is being developed to use increased smolt production (i.e., yield) at full seeding as the best measure of benefit from a habitat enhancement project. Determination of full benefit from a project depends on completion or maturation of the project and presence of adequate numbers of fish to document actual increases in fish production. The depressed nature of up river anadromous stocks have precluded measuring full benefits of any habitat project in Idaho. The IDFG role in physical habitat monitoring is primarily to link habitat quality or habitat change to changes in actual and potential fish production. Estimation of anadromous fish response to BPA habitat projects in Idaho is generally the responsibility of IDFG. The IDFG evaluation approach consists of three basic, integrated levels: general monitoring, standing crop evaluations, and intensive studies. Annual general monitoring of anadromous fish densities in a small number of sections for each project will be used to follow population trends and define seeding levels. For most projects, standing crop estimate of parr will be used to estimate smolt production by factoring appropriate survival rates from parr-to-smolt stages. 26 refs., 7 figs., 18 tabs.

23665 (DOE/BP/35885–2) **Smolt survival workshop: Proceedings.** Anderson, J.J. (Washington Univ., Seattle, WA (USA). School of Fisheries); Dauble, D.D.; Neitzel, D.A. Washington Univ., Seattle, WA (USA). School of Fisheries; Pacific Northwest Lab., Richland, WA (USA). Sep 1989. 107p. Sponsored by U.S. DOE Management & Administration. DOE Contract AI79-87BP35885;AC06-76RL01830. (CONF-8902165–Summ.: Smolt survival workshop, Friday Harbor, WA (USA), 1-3 Feb 1989). Order Number DE90008451. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

A workshop was held at the University of Washington Laboratory to evaluate measures of juvenile salmon and steelhead survival and to recommend approaches for future studies in the Columbia River. Specific workshop goals included: review standards used to evaluate survival in previous studies and agree on standards for future studies, evaluate existing methods for determining survival, recommend types of survival studies that can be conducted with existing techniques, identify new approaches and facilities for improving survival estimates, and reach consensus on future directions for survival studies. 5 figs., 4 tabs.

14 SOLAR ENERGY

1401 Resources and Availability

Refer also to citation(s) 23666

1404 Environmental Aspects

23666 (SAND–90-0438C) **Perspectives on solar energy and the environment.** Hartley, D.L.; Schueler, D.G. Sandia National Labs., Albuquerque, NM (USA). [1990]. 14p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. (CONF-900377–3: Energy and the environment in the 21st century, Cambridge, MA (USA), 26-28 Mar 1990). Order Number DE90007680. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Over the next several decades, it is expected that the use of renewable energy technologies will greatly expand as these technologies mature, as the cost of conventional energy supply increases, and as the environmental impact of fossil fuel usage is better understood. A critical question is whether the impact of renewables, in terms of displaced fossil fuel use and reduced environmental effects, can be significant. Certainly, public policy will have dramatic effects on this question. Given a positive policy environment, renewables have the potential to displace a significant fraction of projected energy use within 30-40 years. For the United States, renewables could contribute as much as 25-55 exajoules of energy annually by the year 2030, or 15-35% of the projected total US energy consumption. 12 refs., 6 figs.

1405 Solar Energy Conversion

23667 (AFME–86-91-0006) **Energy pilot experimentation group (GEPE) annual report.** Anon. Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). 1987. 100p. (In French). Order Number DE90761940. Available from NTIS (US Sales Only), PC A05/MF A01.

The Group for Experiment of Energy pilots (GEPE), jointly sponsorized by AFME and CEA, is concerned with R and D studies on renewable energies utilization and energy rational utilization. The 1986 activities of the group focused on four main subjects: tests and experiments of photovoltaic systems (electricity production, refrigerating systems), research and development of new components for photovoltaic cells, experiments and standard tests on passive solar space heating systems, and heat storage.

23668 (PB–90-140781/XAB) **Production of extracellular nucleic acids by genetically altered bacteria in aquatic-environment microcosms.** Paul, J.H.; David, A.W. University of South Florida, St. Petersburg, FL (USA). Dept. of Marine Science. c 1989. 7p. Available from NTIS, PC A02/MF A01.

Pub. in Applied and Environmental Microbiology, Vol. 55, No. 8, 1865-1869(Aug 1989).

Factors which affect the production of extracellular DNA by genetically altered strains of Escherichia coli, Pseudomonas aeruginosa, Pseudomonas cepacia, and Bradyrhizobium japonicum in aquatic environments were investigated. The presence or absence of the ambient microbial community had little effect on the production of extracellular DNA. Results indicate the extracellular-DNA production by genetically altered bacteria released into aquatic environments is more strongly influenced by physiochemical factors than biotic factors; extracellular-DNA production rates are usually greater for organisms released in freshwater than marine environments; and ambient microbial populations can readily utilize materials released by these organisms.

23669 (PB–90-140823/XAB) **Turnover of extracellular DNA in eutrophic and oligotrophic freshwater environments of southwest Florida.** Paul, J.H.; Jeffrey, W.H.; David, A.W.; DeFlaun, M.F.; Cazares, L.H. University of South Florida, St. Petersburg, FL (USA). Dept. of Marine Science. c 1989. 8p. Available from NTIS, PC A02/MF A01.

Pub. in Applied and Environmental Microbiology, Vol. 55, No. 7, 1823-1828(Jul 1989).

Turnover of extracellular DNA was investigated in oligotrophic springs of the Crystal River and the eutrophic Medard Reservoir of southwest Florida. The Medard Reservoir possessed large populations of bacterioplankton and phytoplankton (6.8 x 10 sup 9 cells per liter and 28.6 micrograms of chlorophyll a per liter, respectively), while the Crystal River springs only contained a fraction of the microbial biomass found in the Medard Reservoir. The results indicate that regardless of trophic status or microbial standing stock, extracellular DNA turns over rapidly in subtropical planktonic freshwater environments. Therefore, recombinant DNA sequences from released genetically engineered microorganisms might not be expected to survive for long periods of time in freshwater planktonic environments.

23670 (SERI/TP–211-3666) **Characterization and comparison of optically transparent conducting films: Final subcontract report, 1 October 1988–30 November 1989.** Gordon, R.G. (Harvard Univ., Cambridge, MA (USA)). Solar Energy Research Inst., Golden, CO (USA). Mar 1990. 54p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE90000319. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Textured tin oxide films with high light-trapping efficiency, high electrical conductivity and high transparency were successfully grown at high rates by chemical vapor deposition. This process has achieved large-scale commercial production of substrates for amorphous silicon solar cells. Highly transparent and highly conductive films of fluorine-doped zinc oxide were formed by a new CVD process. Increases in the texture (light-trapping) and growth rate are needed to make this a practical process for making substrates for solar cells. Decreases in deposition temperature are needed to make successful back contacts. A hybrid TCO consisting of textured tin oxide covered with a thin, smooth fluorine-doped zinc oxide layer combines the best features of these two materials. It shows efficient light-trapping because of the textured tin oxide, combined with the good resistance of zinc oxide to the hydrogen plasma used to deposit the amorphous silicon. Highly conductive and reflective titanium nitride was deposited under conditions mild enough to form back contacts on amorphous silicon solar cells. Actual cells will be coated and tested in the next contract period. Further optimization of the deposition conditions for these materials should be carried out in collaboration with solar cell manufacturers. 41 refs., 31 figs., 7 tabs.

1406 Photovoltaic Power Systems

Refer also to citation(s) 23667, 23828

23671 (AFME–87-09-0073) **Niaga Woloff wind-solar power station (Senegal).** Anon. Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). 1988. 29p. (In French). Order Number DE90761947. Available from NTIS (US Sales Only), PC A03/MF A01.

The small power station (around 10 000 W) is composed of a photovoltaic generator (160 modules), a wind turbine, an energy storage and regulating system and a converter. The design characteristics, performances and operation experience are presented. Perspectives are outlined. The village supply network is also described.

1407 Solar Thermal Power Systems

23672 (SAND–89-7028) **Design and demonstration of an improved stretched-membrane heliostat.** Sandia National Labs., Albuquerque, NM (USA); Solar Kinetics, Inc., Dallas, TX (USA). Dec 1989. 101p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. Order Number DE90007904. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

Improvements to a stretched-membrane heliostat have been designed and implemented under contract with Sandia National Laboratories. Specific improvements were made to the mirror module to improve performance and reduce costs. The performance of the heliostat in windy conditions was improved by adding a restraint to the rear membrane. An open-section ring was used to increase structural efficiency. The rear structure was redesigned to take advantage of common manufacturing techniques and lower cost materials. The control system was improved, and a means of achieving passive defocus was achieved. Finally, membrane preload was applied with nonconsumable tooling. An 8% reduction in mirror-module cost was realized. The improved design was successfully demonstrated with a 50-m^2 prototype. This prototype had

improved optical stability in fluctuating winds. Its slope error in calm winds was measured to be 1.3 mrad. 17 refs., 68 figs., 8 tabs.

1408 Ocean Energy Systems

23673 (SERI/TR–253-3549) **Innovative turbine concepts for open-cycle OTEC [ocean thermal energy conversion]: Final report.** Massachusetts Inst. of Tech., Cambridge, MA (USA); Texas A and M Univ., College Station, TX (USA); Pennsylvania Univ., Philadelphia, PA (USA). Dec 1989. 70p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE90000315. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report summarizes the results of preliminary studies conducted to identify and evaluate three innovative concepts for an open-cycle ocean thermal energy conversion (OTEC) steam turbine that could significantly reduce the cost of OTEC electrical power plants. The three concepts are (1) a crossflow turbine, (2) a vertical-axis, axial-flow turbine, and (3) a double-flow, radial-inflow turbine with mixed-flow blading. In all cases, the innovation involves the use of lightweight, composite plastic blading and a physical geometry that facilitates efficient fluid flow to and from the other major system components and reduces the structural requirements for both the turbine or the system vacuum enclosure, or both. The performance, mechanical design, and cost of each of the concepts are developed to varying degrees but in sufficient detail to show that the potential exists for cost reductions to the goals established in the US Department of Energy's planning documents. Specifically, results showed that an axial turbine operating with 33% higher steam throughput and 7% lower efficiency than the most efficient configuration provides the most cost-effective open-cycle OTEC system. The vacuum enclosure can be significantly modified to reduce costs by establishing better interfaces with the system. 33 refs., 26 figs., 11 tabs.

1409 Solar Thermal Utilization

Refer also to citation(s) 23676, 23677, 23678

23674 (AFME–86-04-0114) **A direct solar floor heating.** Jean, A. Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). 1988. 14p. (In French). Order Number DE90761943. Available from NTIS (US Sales Only), PC A03/MF A01.

The Direct Solar Floor Heating system presented here uses a flat plate solar collector and a transfer group. An advanced selective absorber, to be used as a covering collector, is developed together with special connecting collectors. Fluid transfer apparatus has been enhanced, especially with respect to tube degassing. A designing software is also presented.

1410 Solar Collectors and Concentrators

23675 (SAND–89-7040) **Selection and design of a stretched-membrane heliostat for today's markets.** Beninga, K. (Science Applications International Corp., San Diego, CA (USA). Energy Projects Div.); Davenport, R.; Sandubrae, J. Sandia National Labs., Albuquerque, NM (USA); Science Applications International Corp., San Diego, CA (USA). Energy Projects Div. Jan 1990. 178p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. Order Number DE90007997. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

Science Applications International Corporation has designed a complete, integrated stretched-membrane heliostat. The present state-of-the-art is a single-pedestal that does not take advantage of the unique characteristics of stretched-membrane mirror modules and does not allow face-down stow. It was desired to seek more cost-effective designs for use with stretched membrane mirrors. Many stretched-membrane heliostat drive system designs were generated and evaluated relative to the pedestal design. The two most promising alternate designs were determined to be a dual module design and a shared support design. Further refinement and cost analysis led to the selection of the dual module heliostat as the preferred design. The dual module design was estimated to cost about 18% less than a pedestal heliostat over its lifetime, and was determined to have the best near-term development potential of all the designs studied. This design incorporates long-sought features such as face-down stow as well as proven technology such as the single pedestal-mounted drive unit. A 100-m^2 dual module heliostat was designed. Detailed design studies and manufacturing cost estimates were performed. The SAIC dual module heliostat is structurally optimized and cost efficient. At a production rate of 5000 heliostats per year, the installed cost of the dual module heliostat is estimated to be \$107/m^2 (\$10/ft^2) and the total lifetime cost (including O&M costs) is estimated to be \$139/m^2 (\$13/ft^2). 11 refs., 63 figs., 11 tabs.

23676 (TNO-TPD–303.219A) **Reliability and durability of the solar boiler system of the GE in The Hague, Netherlands.** Brethouwer, D.E.; Schoonewille, H. Nijverheidsorganisatie TNO, Delft (Netherlands). Technisch Physische Dienst. Dec 1987. 23p. (In Dutch). Order Number DE90752699. Available from NTIS (US Sales Only), PC A03/MF A01.

Next to costs and energy yield the economic efficiency of solar heating systems is influenced by service life and technical operation. The Institute of Applied Physics of the Netherlands Organization for Applied Scientific Research (TNO) inspected three types of solar heating systems on a regular basis. Also maintenance services were consulted to make an inventory of desired maintenance work. The survey concerned common solar boiler systems in four apartments in Amstelveen, Netherlands, 86 separate solar boilers in Gaasperdam, Netherlands, and a solar boiler system of the Municipal Energy Company in Den Haag (The Hague). The three systems are discussed in separate reports of which abstracts were prepared. This report discusses the system in The Hague. The inspection procedure and the collective hot water system are described. The experiences during the survey are also discussed: a summary is given of all the relevant problems and failures. It is concluded that service life and reliability of the system are good.

23677 (TNO-TPD–303.219B) **Reliability and durability of 86 solar boiler systems in Gaasperdam, Netherlands.** Brethouwer, D.E.; Schoonewille, H. Nijverheidsorganisatie TNO, Delft (Netherlands). Technisch Physische Dienst. Dec 1987. 20p. (In Dutch). Order Number DE90752700. Available from NTIS (US Sales Only), PC A03.

Next to costs and energy yield the economic efficiency of solar heating systems is influenced by service life and technical operation. The Institute of Applied Physics of the Netherlands Organization for Applied Scientific Research (TNO) inspected three types of solar heating systems on a regular basis. Also maintenance services were consulted to make an inventory of desired maintenance work. The survey concerned common solar boiler systems in four apartments in Amstelveen, Netherlands, 86 separate solar boilers in Gaasperdam, Netherlands, and a solar boiler system of the Municipal Energy Company in Den Haag (The Hague). The three systems are discussed in separate reports of which abstracts were prepared. This report discusses the systems in Gaasperdam. The inspection procedure, the collective hot water and space heating systems are described. The experiences during the survey are also discussed: a summary is given of all the relevant problems and failures. It is concluded that service life and reliability of the boilers are poor, especially with regard to the circulation pump, the control equipment and corrosion of the absorbers. 1 ref., 1 app.

23678 (TNO-TPD–303.219C) **Reliability and durability of some collective solar boiler systems in Amstelveen, Netherlands.** Brethouwer, D.E.; Schoonewille, H. Nijverheidsorganisatie TNO, Delft (Netherlands). Technisch Physische Dienst. Apr 1988. 24p. (In Dutch). Order Number DE90752701. Available from NTIS (US Sales Only), PC A03.

Next to costs and energy yield the economic efficiency of solar heating systems is influenced by service life and technical operation. The Institute of Applied Physics of the Netherlands Organization for Applied Scientific Research (TNO) inspected three types of solar heating systems on a regular basis. Also maintenance services were consulted to make an inventory of desired maintenance work. The survey concerned common solar boiler

systems in four apartments in Amstelveen, Netherlands, 86 separate solar boilers in Gaasperdam, Netherlands, and a solar boiler system of the Municipal Energy Company in Den Haag (The Hague). The three systems are discussed in separate reports of which abstracts were prepared. This report discusses the systems in Amstelveen. The inspection procedure, the collective hot water and space heating systems are described. The experiences during the survey are also discussed: a summary is given of all the relevant problems and failures. It is concluded that service life and reliability of the system are poor.

23679 (TNO-TPD–714.004) **Inventory of condensation problems of solar collectors.** Van der Linden, J.; Havinga, J. Nijverheidsorganisatie TNO, Delft (Netherlands). Technisch Physische Dienst. Jun 1988. 32p. (In Dutch). Contract PEO 23.21-008.10. Order Number DE90752698. Available from NTIS (US Sales Only), PC A03/MF A01.

Results of a literature study on condensation in and its effect on a solar collector are presented. It appears that much practical research has been carried out on the subject, although of a qualitative nature. No statements have been made on quantitative effects of condensation or the conditions under which condensation occurs. Therefore some own experimental results are added. The most important conclusion is that the collector tray must be provided with ventilation holes and drainage openings. The appendices give impressions of the consulted references. 3 figs., 20 refs., 1 tab., 2 apps.

1420 Heat Storage

Refer also to citation(s) 23667

15 GEOTHERMAL ENERGY

1501 Resources and Availability

23680 (DOE/CE–0283) **Geothermal Progress Monitor report No. 11.** USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (USA). Geothermal Technology Div. Dec 1989. 77p. Sponsored by U.S. DOE Conservation & Renewable Energy. Order Number DE90008296. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This issue of the Geothermal Progress Monitor (GPM) is the 11th since the inception of the publication in 1980. It continues to synthesize information on all aspects of geothermal development in this country and abroad to permit identification and quantification of trends in the use of this energy technology. In addition, the GPM is a mechanism for transferring current information on geothermal technology development to the private sector, and, over time, provides a historical record for those interested in the development pathway of the resource. In sum, the Department of Energy makes the GPM available to the many diverse interests that make up the geothermal community for the multiple uses it may serve. This issue of the GPM points up very clearly how closely knit many of those diverse interests have become. It might well be called an "international issue" since many of its pages are devoted to news of geothermal development abroad, to the efforts of the US industry to participate in overseas development, to the support given those efforts by federal and state agencies, and to the formation of the International Geothermal Association (IGA). All of these events indicate that the geothermal community has become truly international in character, an occurrence that can only enhance the future of geothermal energy as a major source of energy supply worldwide. 15 figs.

23681 (DOE/IE/10574–T2) **Radar imagery interpretation to provide information about several geothermal sites in the Philippines.** Arkansas Research Consultants, Inc., Fayetteville, AR (USA). 17 Nov 1988. 45p. Sponsored by U.S. DOE Management & Administration. DOE Contract FG01-87IE10574. (ARCI-TR–8701-102). Order Number DE90008795. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The Republic of the Philippines is intensely interested in the identification, development, and conservation of natural resources. In keeping with this, the Government of the Philippines has recently completed a nation-wide sedimentary basin evaluation program to assess hydrocarbon potential and assist in future exploration activities. This program of collection and interpretation of the radar imagery was designed to augment and complement the existing data base. The primary objective of the project was to further the goals of international energy development by aiding the Republic of the Philippines in the assessment of potential geothermal and petroleum prospects within the areas imaged. Secondary goals were to assist the Republic of the Philippines in utilizing state-of-the-art radar remote sensing technology for resource exploration, and to train key Philippines scientists in the use of imaging radar data. 7 refs., 20 figs., 2 tabs.

23682 (DOE/IE/10574–T3) **Radar imagery interpretation to assess the hydrocarbon potential of four sites in the Philippines.** Arkansas Research Consultants, Inc., Fayetteville, AR (USA). 17 Nov 1988. 208p. Sponsored by U.S. DOE Management & Administration. DOE Contract FG01-87IE10574. (ARCI-TR–8701-101). Order Number DE90008796. Available from NTIS, PC A14/MF A01 - OSTI.

The Republic of the Philippines is intensely interested in the identification, development, and conservation of natural resources. In keeping with this, the Government of the Philippines has recently completed a nationwide sedimentary basin evaluation program to assess hydrocarbon potential and assist in future exploration activities. This program of collection and interpretation of the radar imagery was designed to augment and complement the existing data base. The primary objective of the project was to further the goals of international energy development by aiding the Republic of the Philippines in the assessment of potential petroleum and geothermal prospects within the areas imaged. Secondary goals were to assist the Republic of the Philippines in utilizing state-of-the-art radar remote sensing technology for resource exploration, and to train key Philippines scientists in the use of imaging radar data. 29 refs., 30 figs., 14 tabs.

23683 (DOE/IE/10574–T3-Exec.Summ.) **Executive summary: Radar imagery interpretation to assess the hydrocarbon potential of four sites in the Phillipines.** Arkansas Research Consultants, Inc., Fayetteville, AR (USA). 17 Nov 1988. 69p. Sponsored by U.S. DOE Management & Administration. DOE Contract FG01-87IE10574. (ARCI-TR–8701-103). Order Number DE90008797. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The Republic of the Philippines is intensely interested in the identification, development, and conservation of natural resources. In keeping with this, the Government of the Philippines has recently completed a nationwide sedimentary basin evaluation program to assess hydrocarbon potential and assist in future exploration activities. This program of collection and interpretation of the radar imagery was designed to augment and complement the existing data base. The primary objective of the project was to further the goals of international energy development by aiding the Republic of the Philippines in the assessment of potential petroleum and geothermal prospects within the areas imaged. Secondary goals were to assist the Republic of the Philippines in utilizing state-of-the-art radar remote sensing technology for resource exploration, and to train key Philippines scientists in the use of imaging radar data. 9 refs., 9 figs., 3 tabs.

1503 Geothermal Exploration and Exploration Technology

23684 (IAEA-TECDOC–502, pp. 427-430) **Isotopic composition of thermal waters in central Mexico.** Quijano, J.L. (Comision Federal de Electricidad, Morelia (Mexico). Gerencia de Proyectos Geotermoelectricos). International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico),

28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

We report chemical and isotopic results of cold and thermal springs of central Mexico. Cold springs are fed by aquifers with fast circulation of water having the isotopic composition of modern precipitation. The isotopic values obey Craig's relationship, with in some cases a deuterium excess of 4 per mille. Thermal springs are associated with faults and fractures. Their isotopic composition is characterised by a ^{18}O shift and a δD value lower than that of cold springs. We conclude that there is not a direct relationship between modern meteoric waters and geothermal waters. Although geothermal water is eventually of meteoric origin, little is known of its isotopic and chemical history before reaching the hydrothermal convective systems. (author). 3 refs, 2 figs.

23685 C_1-C_8 hydrocarbons in sediments from Guaymas Basin, Gulf of California: Comparison to Peru margin, Japan Trench and California borderlands. Whelan, J.K. (Woods Hole Oceanographic Institution, MA (USA)); Tarafa, M.E.; Simoneit, B.R.T. *Organic Geochemistry (UK),* 12(2): 171-194 (1988). DOE Contract FG02-86ER13466.

Surface sea floor sediments, hydrothermal vent samples, and Deep Sea Drilling Project sediments (Hole 481 A) from the Guaymas Basin were examined for C_1-C_8 hydrocarbons. The proportions of various classes of compounds were examined and compared to those from other geographic areas (Peru upwelling region and Japan Trench) to gain insight into the relative importance of thermal generation, migration and biodegradation. Concentrations of C_2-C_7 hydrocarbons were about 10-10,000 times higher in geothermally warm Guaymas Basin sediments in comparison to the low concentrations (0.1-10 ppb per compound) typical of geothermally cold sea floor and DSDP diatomaceous sediments. Alkene/alkane ratios of 0.1 or greater were typical of both geothermally cold sediments and also of very hydrocarbon-rich Alvin samples recovered from the sea floor. Because little or no alkene was generally detected in buried sediments exposed to geothermal temperatures greater than 30C, it is suggested that the alkenes are produced by biogenic processes. Normal alkanes predominated over cyclic and branched structures in geothermally cooler (<20°C) sediments, with the proportion of cyclic and branched compounds increasing in hotter sediments. Similarities in compositions of branched and cyclic compounds were observed in some pairs of bitumen-rich Guaymas sea floor samples recovered from different areas, suggesting common mechanisms of light hydrocarbon generation and/or migration. 76 refs.

1505 Economic, Industrial, and Business Aspects

Refer also to citation(s) 23680

1508 Geothermal Power Plants

Refer also to citation(s) 23680

1509 Geothermal Engineering

Refer also to citation(s) 23854

23686 (AFME-86-06-0008) **Chemical additives effects on the corrosion and precipitations in geothermal water at Villiers-le-Bel/Gonesse.** Anon. Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). 1986. 108p. (In French). Order Number DE90761944. Available from NTIS (US Sales Only), PC A06/MF A01.

Two chemical additives were tested to inhibit or moderate the corrosion rate in a geothermal water tubular system. The geothermal water is sodic chlorinated. The first additive (Aquaprox MD 1030 from Protex) has a dispersive and sequestering effect; the second one (Norust 471 from CECA) has a corrosion inhibitory effect and is bactericidal. Results are presented.

1510 Direct Energy Utilization

Refer also to citation(s) 23680

17 WIND ENERGY

Refer also to citation(s) 23671

1701 Resources and Availability (Climatology)

Refer also to citation(s) 23693

23687 (ETSU-N-114, pp. 159-173) **Estimation of the UK wind energy resource using computer modelling techniques.** Burch, S.F. (UKAEA Atomic Energy Research Establishment, Harwell (UK). Materials Physics and Metallurgy Div.); Newton, K. UKAEA Atomic Energy Research Establishment, Harwell (UK). Energy Technology Support Unit; Department of Energy, London (UK). Nov 1988. (CONF-8806461-: Workshop on site windspeed estimation, Norwich (UK), 29 Jun - 1 jul 1988). In *Windspeed estimation at potential wind turbine sites: Proceedings of a UEA-D En workshop held at Norwich, GB, 29 June - 1 July 1988.* Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks. Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks.

A programme is under way to provide quantitative estimates of the UK wind energy resource using a mesoscale numerical model for the prediction of wind flow over complex terrain, in conjunction with digitised terrain data and wind data from surface meteorological stations. A network of suitable meteorological stations has been chosen and the wind data requirements have been specified. Digitised terrain data for the whole UK have been obtained, and different smoothing strategies investigated. Wind flow modelling using the NOABL computer programme will be performed on 100x100 km square regions on a 1km resolution grid, with some complex regions at 2km resolution. (author).

23688 (RISO-M-2827) **Mean wind statistics from 70 m above the Great Belt.** Jensen, N.O.; Troen, I. Risoe National Lab., Roskilde (Denmark). Meteorology and Wind Energy. Oct 1989. 30p. Order Number DE90760178. Available from NTIS (US Sales Only), PC A03/MF A01.

A little more than 10 years of wind measurements are analysed and presented in terms of the parameters A and k of Weibull distributions fitted to the data. The variation of these parameters with wind direction and time of year are presented graphically. The measurements were taken from the 70 m level of the meteorological tower on Sprogoe. (author) 2 tabs., 18 ills., 5 refs.

23689 (RISO-M-2828) **Gust statistics for the Great Belt region.** Jensen, N.O.; Kristensen, L. Risoe National Lab., Roskilde (Denmark). Meteorology and Wind Energy. Oct 1989. 19p. Order Number DE90760179. Available from NTIS (US Sales Only), PC A03/MF A01.

Some statistical analyses of data on short-term wind fluctuations (3 sec. averages) are presented. The measurements are obtained from a 70 m high tower situated on a small island. A simple theory for average gusts is summarized. The results of the analyses are compared to the Danish wind code. (author) 2 tabs., 4 ills., 8 refs.

23690 (RISO-M-2829) **Extreme values of wind speeds over the Great Belt region.** Jensen, N.O.; Nielsen, B. Risoe National Lab., Roskilde (Denmark). Meteorology and Wind Energy. Oct 1989. 20p. Order Number DE90760180. Available from NTIS (US Sales Only), PC A03/MF A01.

A little more than 10 years of wind data measured at the height of 70 m above a small island has been used to estimate the wind speed at the expected 50 year return period. The finding is 32 m/s which is considerably smaller than the Danish wind code. Further reduction to approx 27 m/s is obtained when the projection perpendicular to the projected bridge is considered. (author) 5 tabs., 4 ills., 9 refs.

1704 Economic, Industrial, and Business Aspects

Refer also to citation(s) 23693

1706 Wind Energy Engineering

Refer also to citation(s) 23864

23691 (DMI–87835-Vol.1) **Siting of wind turbines near buildings and obstacles: DMI wind-tunnel investigations. Technical note. EEC-project.** Ingham, P. Skibsteknisk Laboratorium, Lyngby (Denmark). Oct 1987. 21p. Order Number DE90760227. Available from NTIS (US Sales Only), PC A03/MF A01.

The background for this note is the description of job B-2 in research project: "Siting of Wind Turbines near Buildings and Obstacles". The scope of this work is to report measurements, carried out in the wind tunnel at DMI, and make a proposal to supplementary measurements. A model of a farm in scale 1:100 was studied in the boundary-layer wind tunnel. The change in the means velocity of the flow caused by the model was studied in simulated boundary layers, which corresponds to full-scale boundary layers. The report shows that it should be possible to measure the influence of a building on a wind turbine's power production in full-scale on the actual farm placed at Sjaellands Odde, Denmark. (author).

23692 (DMI–87835-Vol.2) **Siting of wind turbines near buildings and obstacles: Results from full-scale measurements. Technical note. EEC-project.** Jensen, A.G. Skibsteknisk Laboratorium, Lyngby (Denmark). Sep 1988. 42p. Order Number DE90760231. Available from NTIS (US Sales Only), PC A03/MF A01.

This note presents the results of full scale measurements of wake behind a building. The measurements have been carried out as part B-1 of the resarch project "Siting of Wind Turbines near Buildings and Obstacles". The full-scale measurements have been carried out on a farm placed at Sjaellands Odde, Denmark in the period from October 1987 to September 1988. The wind speed, turbulence and wind direction have been measured at three heights 24 m, 18 m and 12 m on two posotions, one upwind in front of the farm buildings and one 200 m downwind behind the farm buildings. The above measurements are presented as plots and tables in this report. The measurements of the wind speed reduction is shown in chapter 5 and the measurements of turbulence and wind direction is shown in appendices, an appendix for each height. (author).

23693 (DOE/CH/10093–64) **Wind energy program summary: Volume 1, Overview, Fiscal year 1989.** Solar Energy Research Inst., Golden, CO (USA). Jan 1990. 16p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE89009479. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A new wind is sweeping our country. It's a shared desire, both public and private, to preserve our environment. To manage our technology and our resources in the most efficient manner possible. To ensure our standard of living, yet allow for growth and prosperity. Wind power is already helping the United States to meet these challenges, with about 1400 megawatts (MW) of installed wind turbine capacity on-line to utilities primarily in California and Hawaii. And according to a recent report by the Electric Power Research Institute (EPRI), the best of today's wind turbines are performing well. When located in sites with good wind resources, today's superior designs have energy costs of about 8¢/kilowatt-hour (kWh), a price competitive with some forms of conventional power. The EPRI report also found that operation and maintenance costs for the best machines can be as low as 0.5¢/kWh, comparable to that of conventional power-producing technologies, if on-site maintenance facilities are available. These achievements are remarkable for a technology that began generating utility-scale power just a decade ago, after oil embargoes first imperiled US energy security in 1973. Today's wind turbines can produce cost-competitive electricity only in areas where wind speeds annually average an energetic 18 mph or more. 23 figs.

23694 (ETSU-N–114) **Windspeed estimation at potential wind turbine sites.** Davies, T.D. (comp.). UKAEA Atomic Energy Research Establishment, Harwell (UK). Energy Technology Support Unit; Department of Energy, London (UK). Nov 1988. 181p. (CONF-8806461–: Workshop on site windspeed estimation, Norwich (UK), 29 Jun - 1 jul 1988). Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks. Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks.

The Workshop was convened 29 June - 1 July 1988, at the University of East Anglia in Norwich, in order to bring together most of the UK practitioners in windspeed estimation techniques for candidate wind turbine sites. The Workshop was a logical development from the One-day Workshop on Wind Turbines - Meteorology, Siting and Monitoring held at the National Engineering Laboratory, East Kilbride in September 1987 covering aspects such as wind measurement, data, wind climatology as well as site collection. The Norwish Workshop focused on windspeed prediction techniques. (author).

23695 (ETSU-N–114, pp. 5-8) **The necessity for site windspeed estimation methodologies.** Holt, J.S. (Central Electricity Generating Board, London (GB). Technology Planning and Research Div.). UKAEA Atomic Energy Research Establishment, Harwell (UK). Energy Technology Support Unit; Department of Energy, London (UK). Nov 1988. (CONF-8806461–: Workshop on site windspeed estimation, Norwich (UK), 29 Jun - 1 jul 1988). In *Windspeed estimation at potential wind turbine sites: Proceedings of a UEA-D En workshop held at Norwich, GB, 29 June - 1 July 1988.* Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks. Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks.

Site windspeed characteristics (primarily in terms of annual mean windspeed but also turbulence and wind shear) are critical to the assessment of the economic viability of any wind power project. Annual mean windspeed at hub-height influences the design and determines the potential yield while turbulence levels and wind shear can influence design, siting, maintenance costs and availability. Between 1981 and 1986 some 15000 wind turbines with a cumulative capacity of over 1250 MW were installed in California. During this time the capital costs of machines per installed kW halved. Current prices indicate that wind farms supplying electricity to the grid could be economic in the UK on sites with annual mean windspeeds above 8m/s (although there are still many uncertainties including machine lifetime and maintenance costs). (author).

23696 (ETSU-N–114, pp. 9-26) **Boundary layer flow over hills.** Mason, P.J. (Meteorological Office, Bracknell (UK)). UKAEA Atomic Energy Research Establishment, Harwell (UK). Energy Technology Support Unit; Department of Energy, London (UK). Nov 1988. (CONF-8806461–: Workshop on site windspeed estimation, Norwich (UK), 29 Jun - 1 jul 1988). In *Windspeed estimation at potential wind turbine sites: Proceedings of a UEA-D En workshop held at Norwich, GB, 29 June - 1 July 1988.* Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks. Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks.

An understanding of flow in the atmospheric boundary layer is essential for wide range of applications. Estimates of the net momentum, heat and moisture fluxes are required for numerical weather prediction models whilst information on detailed flow structures is needed for applications such as pollution dispersion, wind power studies, agriculture and the siting and strength of buildings. In what follows, neutral static stability flow over a low hill is considered first. The dynamics which determine the changes in mean flow and turbulence are outlined and estimates of the changes made. (author).

23697 (ETSU-N–114, pp. 27-33) **Problems of logging wind data at a high moorland site.** Slack, Graham (Northumbrian Energy Workshop Ltd., Acomb (GB)). UKAEA Atomic Energy Research Establishment, Harwell (UK). Energy Technology Support Unit; Department of Energy, London (UK). Nov 1988. (CONF-8806461–: Workshop on site windspeed estimation, Norwich (UK), 29 Jun - 1 jul 1988). In *Windspeed estimation at potential wind turbine sites: Proceedings of a UEA-D En workshop held at Norwich, GB, 29 June - 1 July 1988.* Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks. Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks.

In the absence of proven techniques for extrapolating information on wind regimes at remote sites from existing data, the installation

of wind measuring equipment on site is essential. Most sites of interest for wind power exploitation however, are usually both remote and inhospitable. In such locations equipment installation, power supply and data retrieval pose considerable problems. Some of the major problems of remote wind data logging identified by N.E.W. in the course of some 10 years of field experience are described. Points are illustrated by reference to a wind monitoring programme currently in progress on a high altitudte site in the North Pennines. (author).

23698 (ETSU-N–114, pp. 34-58) **The estimation of wind climatologies from short duration records.** Havard, C.C. (Meteorological Office, Bracknell (UK)); Moores, W.H. UKAEA Atomic Energy Research Establishment, Harwell (UK). Energy Technology Support Unit; Department of Energy, London (UK). Nov 1988. (CONF-8806461–: Workshop on site windspeed estimation, Norwich (UK), 29 Jun - 1 jul 1988). In *Windspeed estimation at potential wind turbine sites: Proceedings of a UEA-D En workshop held at Norwich, GB, 29 June - 1 July 1988.* Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks. Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks.

There is a requirement to estimate wind climatologies for sites at which there is no instrumentation. This information is needed by many users for different purposes. Three typical applications are wind energy conversion; major building projects and for efficient design of anemometer networks. The majority of such needs are satisfied if the wind climatology can be defined in terms of windspeed distribution, categorized by wind direction. (author).

23699 (ETSU-N–114, pp. 59-104) **A simple, non-modelling methodology for the prediction of windspeeds at a candidate wind turbine site.** Bass, Jeremy (Rutherford Appleton Lab., Chilton (UK)); Halliday, Jim; Palutikof, Jean; Davies, Trevor. UKAEA Atomic Energy Research Establishment, Harwell (UK). Energy Technology Support Unit; Department of Energy, London (UK). Nov 1988. (CONF-8806461–: Workshop on site windspeed estimation, Norwich (UK), 29 Jun - 1 jul 1988). In *Windspeed estimation at potential wind turbine sites: Proceedings of a UEA-D En workshop held at Norwich, GB, 29 June - 1 July 1988.* Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks. Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks.

A simple, non-modelling methodology for the prediction of a site's wind-regime in moderately hilly areas is described. The full methodology comprises two main components; a method for removing the effects of the local terrain, ie surface roughness, sheltering and topography, from observed wind speed data and a method for analysing spatial (between site) variation. (author).

23700 (ETSU-N–114, pp. 105-137) **A methodology for predicting windspeeds over hilly terrain.** Palutikof, J.P. (East Anglia Univ. (UK). Climatic Research Unit); Davies, T.D.; Halliday, J.; Bass, J. UKAEA Atomic Energy Research Establishment, Harwell (UK). Energy Technology Support Unit; Department of Energy, London (UK). Nov 1988. (CONF-8806461–: Workshop on site windspeed estimation, Norwich (UK), 29 Jun - 1 jul 1988). In *Windspeed estimation at potential wind turbine sites: Proceedings of a UEA-D En workshop held at Norwich, GB, 29 June - 1 July 1988.* Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks. Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks.

The University of East Anglia and Rutherford Appleton Laboratory are collaborating in a three-year project to study the wind climatology of the UK, with particular to the needs of the wind energy industry. One aim of the UEA/RAL wind project is the design of a methodology to predict windspeeds at candidate wind turbine sites. The methodology is being developed with the objective of being able to be used over hilly terrain as well as flat land and to require only a small financial investment in hardware. (author).

23701 (ETSU-N–114, pp. 138-153) **A methodology for the prediction of wind speeds at potential wind generator sites.** Macmillan, S. (Robert Gordon's Inst. of Technology, Aberdeen (GB). School of Surveying); Saluja, G.S. UKAEA Atomic Energy Research Establishment, Harwell (UK). Energy Technology Support Unit; Department of Energy, London (UK). Nov 1988. (CONF-8806461–: Workshop on site windspeed estimation, Norwich (UK), 29 Jun - 1 jul 1988). In *Windspeed estimation at potential wind turbine sites: Proceedings of a UEA-D En workshop held at Norwich, GB, 29 June - 1 July 1988.* Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks. Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks.

A methodology has been developed to predict the wind speed distributions at potential wind generator sites in the absence of on-site wind data. The model uses wind data from the nearest available meteorological station and transposes it to the prediction site using direction dependent factors. These factors function so as to eliminate effects of upstream transitions in surface roughness and topography at the meteorological station, to transfer the data to the prediction site by accounting for the difference in general elevation above sea level of the two areas, and to incorporate the effects due to local surface characteristics and topography at the prediction site. (author).

23702 (ETSU-N–114, pp. 154-158) **A comparison of two methodologies to predict windspeeds at candidate wind turbine sites.** Guo, X. (East Anglia Univ. (UK). Climatic Research Unit); Palutikof, J.P. UKAEA Atomic Energy Research Establishment, Harwell (UK). Energy Technology Support Unit; Department of Energy, London (UK). Nov 1988. (CONF-8806461–: Workshop on site windspeed estimation, Norwich (UK), 29 Jun - 1 jul 1988). In *Windspeed estimation at potential wind turbine sites: Proceedings of a UEA-D En workshop held at Norwich, GB, 29 June - 1 July 1988.* Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks. Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks.

A principal factor determining the economics of wind energy is windspeed. Several techniques are available for the estimation of windspeeds at sites where observations are not available, including mesoscale mass-consistent models over complex terrain. Here we apply a modified version of the mesoscale model COMPLEX to a hilly area in the Northern Pennines. A comparison of these predictions with those obtained from the application of a set of simple guidelines gives us some useful results. (author).

23703 (ETSU-N–114, pp. 174-178) **Cost effectiveness of site selection procedures for wind turbine sites.** Nicholson, G. (Northumbrian Energy Workshop, Acomb (GB)). UKAEA Atomic Energy Research Establishment, Harwell (UK). Energy Technology Support Unit; Department of Energy, London (UK). Nov 1988. (CONF-8806461–: Workshop on site windspeed estimation, Norwich (UK), 29 Jun - 1 jul 1988). In *Windspeed estimation at potential wind turbine sites: Proceedings of a UEA-D En workshop held at Norwich, GB, 29 June - 1 July 1988.* Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks. Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks.

A major development of wind energy technology has taken place over the last decade, following the oil crisis and fuelled by the pollution problems of other power sources giving impetus to diversify sources of supply. In this ten year development period the focus has been on wind turbine design. Huge improvements in the reliability, safety, performance, durability have been achieved with a greater understanding of the scientific and engineering principles involved. However, the most significant development, from a commercial point of view, is the competitive position of wind energy in relation to all other power generation plant. However the single most important factor affecting wind turbine economics is the wind regime at the respective turbine site. This is because of the cube law relationship between windspeed and wind power. (author).

23704 (NEI-DK–272) **Description of the maximum span of screws in Danish wind turbine blades.** Bugge, J. Nordvestjysk Folkecenter for Vedvarende Energi, Hurup (Denmark). Nov 1988. 26p. (In Danish). Order Number DE90760222. Available from NTIS (US Sales Only), PC A03/MF A01.

Calculations regarding the necessary span of the joint-bolting system used in relation to wind turbine blades, in order to optimize operational safety. (AB).

23705 (NEI-DK–273) **Wind power driven grinding mills for developing countries.** Yde, L. Nordvestjysk Folkecenter for Vedvarende Energi, Hurup (Denmark). Oct 1989. 51p. (In Danish). Contract TR-88.220. Order Number DE90760225. Available from NTIS (US Sales Only), PC A04/MF A01.

Denmark contributes significantly to the export of flour grinding machines for developing countries. Power supply is a problem in rural areas so renewable energy is interesting in this relation. Originally a system based on wind power for driving corn grinding machines had been developed and tested. This consisted basically of a mechanical transmission from the wind turbine blades via a right angle gear and a long axle through the tower to a belt drive over to the grinding machine. There are now more motors involved in the system and the long axle has been substituted with an electric cable and an electric transmission system substitutes the mechanical one. There are two blades of 4 meter diameter, the generator gives 1.5kW and the tower is 2 meters high. This type of wind turbine can be used for many purposes, such as driving a cement mixer, water pump etc. Tests, design and applications of this kind of wind turbine, and of the grinding machine, are presented together with illustrations and operational data. (AB).

23706 (NEI-DK–274) **Construction manual for Darrieus windmill.** Jensen, M.T. Styregruppen for Vedvarende Energi (Denmark). 1989. 26p. (In Danish). Contract TR-86.128. Order Number DE90760226. Available from NTIS (US Sales Only), PC A03/MF A01.

Design of a vertical axis wind turbine, suitable for a 15-20kW generator, in connection with which various types of energy converters can be installed. The windmill is adapted for providing power for individual households or farms. It is estimated that the cost of producing 100 windmills annually would be 100.000 Danish Crowns, which makes it competitive on the current market. Diagrams etc. are provided to illustrate the construction. The wind turbine has an annual production of 20-25.000kWh when placed on inland sites in Denmark, and it has proved to work efficiently on relatively low wind velocities. (AB).

23707 (NEI-DK–293) **Blanking-off and design of 99 KW-"Smedemoellen": Slutrapport over projektet.** Hermansen, K. Maskinforretningen Nymoent, Klemensker (Denmark). Dec 1989. 14p. (In Danish). Contract TR-85.464. Order Number DE90760248. Available from NTIS (US Sales Only), PC A03/MF A01.

In connection with a wind turbine array on the island of Bornholm, Denmark, the aim was to improve the design, and thus the marketing potential of a 99kW "Smedemoelle" wind turbine. Emphasis was on feathering the blades to the wind, (regulating the pitch of the blades). Cooperation with the local smithy and machine shop was considered important. Details of the improvement in design are explained and the text is illustrated with diagrams. (AB).

23708 (RISO-M–2817) **A control concept for wind/diesel systems.** Noergaard, P.; Hansen, J.C. Risoe National Lab., Roskilde (Denmark). Meteorology and Wind Energy. Nov 1989. 39p. Order Number DE90760176. Available from NTIS (US Sales Only), PC A03/MF A01.

This report introduces a control concept for regulation of wind/diesel systems - that is an isolated electric power producing system including diesel-generator set(s) and wind turbine(s). The control concept defined and described is characterized by its simple interface and function and is illustrated in three examples of applied systems. The control strategy and the control logic are described in details and illustrated by route-diagrams (flow charts). The regulations is demonstrated by sample outputs from a computer modelling of the control logic for the three applied systems that clearly illustrates the characteristics of the concept. (author) 9 ills., 4 refs.

23709 (SERI/TP–257-3603) **A comparison of two- and three-dimensional S809 airfoil properties for rough and smooth HAWT [horizontal-axis wind turbine] rotor operation.** Musial, W.D.; Butterfield, C.P.; Jenks, M.D. Solar Energy Research Inst., Golden, CO (USA). Feb 1990. 8p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. (CONF-900136–8: 9. ASME wind energy symposium, New Orleans, LA (USA), 14-17 Jan 1990). Order Number DE89009512. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

At the Solar Energy Research Institute (SERI), we carried out tests to measure the effects of leading-edge roughness on an S809 airfoil using a 10-m, three-bladed, horizontal-axis wind turbine (HAWT). The rotor employed a constant-chord (.457 m) blade geometry with zero twist. Blade structural loads were measured with strain gages mounted at 9 spanwise locations. Airfoil pressure measurements were taken at the 80% spanwise station using 32 pressure taps distributed around the airfoil surface. Detailed inflow measurements were taken using nine R.M. Young Model 8002 propvane anemometers on a vertical plane array (VPA) located 10 m upwind of the test turbine in the prevailing wind direction. The major objective of this test was to determine the sensitivity of the S809 airfoil to roughness on a rotating wind turbine blade. We examined this effect by comparing several parameters. We compared power curves to show the sensitivity of whole rotor performance to roughness. We used pressure measurements to generate pressure distributions at the 80% span which operates at a Reynolds number (Re) of 800,000. We then integrated these distributions to determine the effect of roughness on the section's lift and pressure-drag coefficients. We also used the shapes of these distributions to understand how roughness affects the aerodynamic forces on the airfoil. We also compared rough and smooth wind tunnel data to the rotating blade data to study the effects of blade rotation on the aerodynamic behavior of the airfoil below, near, and beyond stall. 13 refs., 11 figs.

20 FOSSIL-FUELED POWER PLANTS

2001 Power Plants and Power Generation

Refer also to citation(s) 23268, 23413, 23419, 23428, 23915, 23984

23710 (DOE/MC/21023–2758-Vol.2) **Second-generation pressurized fluidized bed combustion plant: Phase 1, Task 2 topical report: Grimethorpe tube bundle "E" wastage evaluation: Volume 2.** Kegel, W. Foster Wheeler Development Corp., Livingston, NJ (USA). Aug 1989. 144p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-86MC21023. Order Number DE90000408. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

This report is the second part of a two-part topical report on Grimethorpe Tube Bundle "E" Wastage Evaluation. Detail drawings, tube material certifications, spent bed and fuel/sorbent analyses, and field photographs make up this report. (JDL)

23711 (DOE/MC/21023–2760) **Second-generation pressurized fluidized bed combustion plant integrated R&D program plan: Phase 1, Task 3 report.** Robertson, A.; Garland, R.; Newby, R.; Rehmat, A.; Rubow, L. Foster Wheeler Energy Corp., Livingston, NJ (USA). May 1989. 62p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-86MC21023. Order Number DE90000414. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report presents a Program Plan together with estimated costs and schedules for satisfying the research and development needs of coal-fired second-generation pressurized fluidized bed combustion plants. This type of plant can operate with a 45-percent efficiency (based on the higher heating value of the coal used as fuel) and achieve a cost of electricity at least 20 percent lower than that of a conventional pulverized coal-fired plant with wet-limestone flue gas desulfurization. The proposed plant concept integrates a coal pyrolyzer/carbonizer with a circulating pressurized fluidized bed combustor (CPFBC). Char produced in the carbonizer is burned in the CPFBC, and the low-Btu fuel gas produced in the carbonizer is burned in a topping combustor to heat the CPFBC exhaust gas to 2100°F and higher before it enters a gas turbine. The carbonizer and CPFBC operate with lime-based sorbents for in-situ sulfur capture in $\leq$1600°F. Components being developed for first-generation PFB combustion plants (gas turbine inlet temperature $\leq$1600°F) protect the gas turbine from corrosion, erosion, and deposition. 28 refs., 15 figs., 3 tabs.

23712 (EPRI-GS–6725) **Proceedings: Fossil plant retrofits for improved heat rate and availability.** Electric Power Research

Inst., Palo Alto, CA (USA). c Dec 1989. 848p. Sponsored by Electric Power Research Institute. (CONF-8712160–: 1. EPRI fossil plant retrofits for improved heat rate and availability conference, San Diego, CA (USA), 1-3 Dec 1987). Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The first EPRI Fossil Plant Retrofits for Improved Heat Rate and Availability conference covered developments from around the world in retrofit technologies for fossil-fuel power plant applications. These proceedings include the 50 papers presented in the following sessions: general; emerging technologies; boiler retrofits; environmental controls; turbine retrofits; performance and plant system interactions; balance-of-plant systems; and controls and diagnostic monitoring. Individual projects are processed separately on the data bases.

23713 (EPRI-GS–6752) **Assessment of asbestos insulation substitutes: Final report.** Fourroux, J.D. (Tennessee Valley Authority, Chattanooga, TN (USA)); Frank, R.L. Jr.; Newberry, T.W. Jr. Electric Power Research Inst., Palo Alto, CA (USA); Tennessee Univ., Chattanooga, TN (USA). School of Engineering; Tennessee Valley Authority, Chattanooga, TN (USA). c Mar 1990. 118p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A state-of-the-art study of asbestos insulation alternatives has been conducted to identify the best substitute material for steam lines in power plants. A survey of utilities across the nation showed that calcium silicate is the most commonly employed material today, followed by mineral wool, fiberglass, and ceramic fibers. However, the calcium silicate was found to be dusty and to become brittle once exposed to elevated temperatures. Although it is asbestos-free, studies on its carcinogenicity are incomplete. Characteristic data on existing substitute materials is compiled and an optimum choice of insulation combination is configured. Potential cost savings of using this combination is evaluated for a major utility. A PC-based computer program is developed to assist utility personnel in selecting the proper insulation materials for steam lines. 31 refs., 8 figs.

23714 (EPRI-GS/ER–6770) **Gas turbine effects on integrated-gasification-combined-cycle power plant operations: Final report.** Eustis, F.H. (Stanford Univ., CA (USA). High Temperature Gasdynamics Lab.). Electric Power Research Inst., Palo Alto, CA (USA); Stanford Univ., CA (USA). High Temperature Gasdynamics Lab. c Mar 1990. 140p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This study used detailed thermodynamic modeling procedures to assess the influence of different gas turbine characteristics and steam cycle conditions on the design and off-design performance of integrated gasification-combined-cycle (IGCC) power plants. IGCC plant simulation models for a base case plant with Texaco gasifiers and both radiant and convective syngas coolers were developed, and three different types of gas turbines were evaluated as well as non-reheat and reheat steam systems. Results indicated that improving the gas turbine heat rate significantly improves the heat rate of the IGCC power plant. In addition results indicated that using a reheat steam system with current gas turbines improves IGCC performance, though as gas turbine efficiency increases, the impact of using a reheat steam system decreases. Increasing gas turbine temperatures from 1985°F to 2500°F was also found to have the potential to reduce overall IGCC system heat rates by approximately 700 BTU/kWh. The methodologies and models developed for this work are extremely useful tools for investigating the impact of specific gas turbine and steam cycle conditions on the overall performance of IGCC power plants. Moreover, they can assist utilities during the preliminary engineering phase of an IGCC project in evaluating the cost effectiveness of using specific gas turbines and steam cycles in the overall plant design. 45 refs., 20 figs., 10 tabs.

23715 (IKU-R–34.2776.00/01/88) **Non-polluting power production combined with enchanced oil recovery: A pilot study.** Holt, T.; Lindeberg, E. Institutt for Kontinentalundersoekelser og Petroleumsteknologi A/S, Trondheim (Norway). May 1988. 64p. (In Norwegian). Order Number DE90760288. Available from NTIS (US Sales Only), PC A04/MF A01.

The report concerns a project dealing with a pilot study of a non-polluting offshore gas power plant combined with gas injection for enchanced oil recovery on the Norwegian continental shelf. The plant is designed for converting considerable amounts of gas volumes for power production and for supplying sufficient volumes of CO_2 for gas injection. This is to be obtained by using the method of stoichiometric gas combustion with oxygen from a gas separation plant or by separating CO_2 from the exhaust gas. The practicability of the project is evaluated, and a profitability analysis for such a project on the Norwegian continental shelf is given. The power output of the plant is evaluated to be between 500 and 2000 MW, and the payback period is calculated to be 7.7 years. 10 figs., 15 tabs., 72 refs.

2002 Waste Management

Refer also to citation(s) 23362, 23368, 23372, 23377, 23917, 24354, 24361, 24362

23716 (CONF-870810–2) **Sub-nanosecond effective pulse widths in positive streamer corona.** Davis, R.H.; Clements, J.S.; Finney, W.C. Florida State Univ., Tallahassee, FL (USA). Dept. of Physics. [1987]. 6p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-86PC91021. From 8. international symposium on plasma chemistry; Tokyo (Japan); 31 Aug - 4 sep 1987. Order Number DE90008821. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The efficiency advantages of short pulse power over DC power in the promotion of chemical reactions by energetic electrons have been previously demonstrated at several laboratories. Power efficiency and electron energy both increase as the pulse is shortened. While further reductions in delivered pulse width are desirable, the lower limit in large practical systems can be tens or even hundreds of nanoseconds. The limits on delivered pulse width may be circumvented by the use of positive streamer corona for which the estimated effective treatment pulse width is 0.1 ns. When positive streamer corona are used, there are two time domains for pulses, the delivered pulse domain and the local treatment pulse domain. The transit time for the streamers sets the minimum width for the delivered pulse. The streamer propagation mechanism determines the width of the actual gas treatment pulse. 6 refs., 4 figs.

23717 (NEI-DK–278) **Pilot system for wet, limestone based process of desulfurizing flue gas.** Voelund Energiteknik A/S, Esbjerg (Denmark). Jan 1989. 109p. (In Danish). Contract EM-1433/85-6. Order Number DE90760233. Available from NTIS (US Sales Only), PC A06/MF A01.

EFP-85.

An executive order was expected to be issued in Denmark in 1988 to the effect that coal with a sulfur content exceeding 0.9% of its weight should not be utilized. This was part of the Danish government's efforts to reduce air pollution from emission of sulfur dioxide. On this basis Voelund Energy A/S initiated a project the aim of which was to develope a wet limestone process for the desulfurization of flue gas from boilers of all sizes. A description of the technological and chemical aspects and operational details is presented. The process is characterized by a high degree of desulfurization, a minimal use of limestone, the use of both calcium carbonate and calcium hydrate as absorbents, a high standard of operational reliability, an empty absorptions tower with a low height, no waste water and the only waste product being a fly ash stabilized calcium sulfate/sulfite slam. As calcium carbonate is significantly cheaper than calcium hydrate this process can be strongly competitive on the current market, especially if government demands for reduction of pollution are tightened. The process is not suitable for plants for the burning of municipal wastes as flue gas from these plants has a high chlorine content in comparison to its sulfur content. (AB) 20 refs.

23718 (NEI-DK–290) **Reburning: International experiences with reburning with special emphasis on reburning fuel injection and mixing.** Byggstoeyl, S. (SINTEF / The Norwegian Institute of Technology, Division of Thermodynamics (Denmark)); Bjoerge, T.; Laksaa, B.; Magnussen, B.F. Nordisk Gasteknisk Center, Hoersholm (Denmark). Jul 1989. 47p. Order Number DE90760253. Available from NTIS (US Sales Only), PC A03/MF A01.

The reburning process is more efficient than other in-furnace NOx reduction techniques. In addition, the corrosion and slagging problem due to high temperature fuel-rich combustion, is avoided. At present, reburning is applied commercially on full scale boilers in Japan. In USA and Europe the technique is still on the pilot scale stage but full scale tests will be done in the near future. Based on a literature survey of experimental results obtained in pilot-scale tests with reburning, the following conclusions can be drawn: - The NOx emission is proportional to the total input of fixed nitrogen to the reburning zone. This makes natural gas well suited as reburning fuel because it contains no fixed nitrogen. - The primary zone stoichiometry should be in the range SR1=1.0-1.2. - the reburning zone stoichiometry, SR2, should be approximately 0.9. - The temperature at the entry of the reburning zone should be as high as possible. When coal with large NH3 production is used as reburning fuel, cooling of the last part of the reburning zone down to the "thermal de-NOx window" will have a favourable effect on the NOx reduction. This makes natural gas doped with NH3 very interesting as reburning fuel. - The residence time in the primary zone should be larger than 330 ms. - The residence time in the reburning zone should be larger than 400 ms. - The reburning technique is only applicable to boilers where the residence time available to the reburning process is larger than approximately 700 ms. - Rapid dispersion and molecular mixing is of main importance for the performance of the reburning process. - High momentum jet injection is favourable for the mixing process. This is also confirmed by theoretical estimates based on semiempirical correlations for turbulent jet mixing. (author) 14 refs.

2004 Health and Safety

Refer also to citation(s) 23713

23719 (PB–90-140757/XAB) **Simulation of airborne microbial droplet transport.** Lighthart, B.; Kim, J. Environmental Protection Agency, Corvallis, OR (USA). Environmental Research Lab. c 1989. 9p. (EPA–600/J-89/200). Available from NTIS, PC A02/MF A01.

Pub. in Applied and Environmental Microbiology, Vol. 55, No. 9, 2349-2355(Sep 1989). See also PB–90-117003.

In the past, large-scale aerial dispersal of microorganisms from sources such as evaporative cooling towers and sewage irrigation and treatment plants has been estimated by using atmospheric dispersion models based on temporal and spatial averaging as defined in the Gaussian plume models. The framework for a simulation model which describes the dispersion of individual droplets of water containing viable microbes is presented. The model accounts for physical, chemical, biological, and measured meteorological parameters of each droplet at each of many short steps. Repeating the modeling process for many droplets will simulate a cloud of droplets. The model is compared with the Tulelake, California release in 1988 and found to show very similar patterns of deposition within 30 m (the maximum observation distance of the source). A hypothesis for the survival sequence in the microbe-containing droplets is discussed.

2005 Environmental Aspects

Refer also to citation(s) 23715, 24351

23720 (BNL–41973) **A process concept for utilizing fossil fuel resources with reduced CO_2 emission.** Steinberg, M. Brookhaven National Lab., Upton, NY (USA). Apr 1989. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-891001–12: International conference on coal science, Tokyo (Japan), 23-27 Oct 1989). Order Number DE90008813. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

There is increasing evidence of the probability of a global carbon dioxide greenhouse warming effect. The concentration of CO_2 in the atmosphere at the turn of the century was 280 ppM; presently it is 345 ppM, an increase of 23%. This increase has resulted mainly from human activity in burning increasing amounts of fossil fuel – coal, oil, gas and from deforestation, the cutting down of forested areas. This paper discusses studies that have been made dealing with reducing CO_2 emissions from coal burning power plants. Included are: CO_2 can be removed, recovered and stored in the deep oceans; recover and utilize CO_2 as a commodity; large acreages of trees can be planted to photosynthetically absorb the CO_2 from fossil fuel plants; and improve energy technology efficiency of existing and future power plants. 5 refs., 1 fig., 3 tabs.

23721 (BNL–42102) **Overview of the methodologies used to compile large scale emissions inventories.** Benkovitz, C.M. Brookhaven National Lab., Upton, NY (USA). [1989]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-8806460–1: 82. annual meeting of association of air pollution control and hazardous waste management, Anaheim, CA (USA), 25-30 Jun 1988). Order Number DE90008518. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Development of emissions inventories for large geographic areas is currently based on the use of "mass balance" equations to estimate the emissions from each source. The general equation used states that the emissions (E) from a particular source for a specific pollutant in a specified time frame are equal to the product of the activity rate of the source (A) in the selected time frame, an emission factor (EF) which estimates the amount of pollutant emitted per unit activity, and additional parameters which vary according to the type of source whose emissions are being estimated. Emissions for large stationary sources (point sources) are calculated on an individual basis; for smaller sources and for mobile sources methodologies currently in use estimate emissions as area aggregates. Values for the parameters and disaggregation factors used in emissions calculations can be estimated in two different ways. "Individual" estimates can be made for the parameters by estimating a value for each source. "Averaged" estimates can be made for some parameters; in this case, the set of all sources is divided into categories that are thought to be internally more homogeneous than the general population. For each of these categories, a value is estimated for the parameter and used to calculate the emissions from all the sources in the category. The objective of this paper is to present an overview of the methodologies currently used to estimate the values of the parameters needed to compile large scale inventories of anthropogenic emissions, to discuss the major approximations used and to offer recommendations for future refinement of the inventory data. 12 refs.

23722 (PB–90-142928/XAB) **Revised estimates of power plant entrainment of ichthyoplankton in western Lake Erie in 1975-77.** Patterson, R.L. Michigan Univ., Ann Arbor, MI (USA). School of Natural Resources. c 1987. 8p. Available from NTIS, PC A02/MF A01.

Pub. in Jnl. of Great Lakes Research 13, No. 1, 78-83(1987).

Previous estimates of larval production and power entrainment, distributed over four power plants, are revised using a lumped parameter method by which power plant mortality is estimated independently of natural mortality. Using the method, mean daily power plant entrainment of four species of ichthyoplankton averaged over three seasons of production (1975-77) ranged from zero to 7.6%. The estimates are statistically consistent with earlier estimates made by a more laborious, distributed parameter technique.

2006 Economic, Industrial, and Business Aspects

Refer also to citation(s) 23712

23723 (EPRI-GS–6672) **Simulator-based training and technology transfer for fossil plants: An R&D plan and technology assessment: Final report.** Stone, H. (General Physics Corp., Columbia, MD (USA)); Scheiwe, D.; Dixon, R.; Fray, R. Electric Power Research Inst., Palo Alto, CA (USA); General Physics Corp., Columbia, MD (USA); TRAX Corp., Lynchburg, VA (USA); Science Applications International Corp., Idaho Falls, ID (USA). c Feb 1990. 200p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A formal working group composed of representatives from utilities, power industry suppliers, and training consultants was formed to determine the present and projected training and technology transfer needs of the fossil power industry. Through group meetings, interviews with utility personnel and EPRI project managers,

and utility visits, a comprehensive R & D Plan, addressing Fossil Power Plant Training and Technology Transfer was formulated. A key element of this R & D Plan is the concept of the Advanced Technology Transfer Network (ATTN), a data exchange and information network to facilitate transfer between EPRI and member utilities. 24 figs., 5 tabs.

21 NUCLEAR POWER PLANTS

2101 Power Reactors, Nonbreeding, Light-Water Moderated, Boiling Water Cooled

Refer also to citation(s) 23541, 23732, 23734, 23769, 23772, 23773, 23774, 23782, 23784, 23785, 23786, 23787, 23788, 23789, 23791

23724 (EPRI-NP–6733) **Decomposition of hydrogen peroxide at elevated temperatures.** Lin, C.C. (General Electric Co., San Jose, CA (USA). Nuclear Energy Div.); Smith, F.R. Electric Power Research Inst., Palo Alto, CA (USA); General Electric Co., San Jose, CA (USA). Nuclear Energy Div. c Mar 1990. 135p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Decomposition of hydrogen peroxide in high-purity water has been measured at temperatures ranging from 100 to 280°C in a laboratory test loop. A first-order decomposition kinetics has been observed in all cases, but the decomposition rates were found to vary widely, depending on the material used in the reaction chamber. In a 1/4 inch OD stainless steel tubing, the decomposition rate constant is estimated at 0.3 sec^{-1} at 280°C and the activation energy is 15 Kcal/mol. This decomposition rate is approximately 100 times faster than that observed in a Teflon tubing. The variation of decomposition rate in different reaction chambers is attributed to the heterogeneous catalytic effects. Hydrogen peroxide is believed to decompose through free radical reactions involving a charge transfer process on material surfaces. It is also observed that there is some, but very little evidence of reaction between H_2 and H_2O_2 in high-purity water at temperatures up to 280°C. Copper ions are found to significantly enhance the H_2O_2 decomposition rate and catalyze the reaction between H_2 and H_2O_2. The effects of H_2O_2 on the electrochemical potentials (ECP) of stainless steel are also investigated (reported separately). Although the exact mechanism is not clear, the increase of ECP by H_2O_2 may be easily explained by the charge transfer process on stainless steel surfaces which provide the catalytic media for the H_2O_2 decomposition. Application of the test results obtained in this program in the water radiolysis model calculation for BWR hydrogen water chemistry is also discussed. 46 refs., 29 figs., 5 tabs.

23725 (NUREG–0975-Vol.6, pp. 241-267) **Environmentally assisted cracking in light water reactors.** Shack, W.J. (Argonne National Lab., IL (USA)); Kassner, T.F.; Maiya, P.S.; Park, J.Y.; Ruther, W. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering. Jun 1988. In *Compilation of contract research for the Materials Engineering Branch, Division of Engineering. Annual report for FY 1987.* Order Number DE88013182. Available from NTIS, PC A18/MF A01 - I.

The objective of this program is the assessment of environmental degradation of reactor structural materials in light-water reactor systems. The scope includes (1) definition of the role of material composition and metallurgical variables, loading history, and water chemistry in environmental degradation of reactor structural materials and (2) evaluation of these variables, within practical limits, on the subsequent degradation of the materials. The primary emphasis is on piping materials. The FY 1987 effort is divided into six subtasks: (A) Evaluation of Nonenvironmental Corrective Actions for stress corrosion cracking (SCC); (B) Evaluation of Environmental Corrective Actions for SCC; (C) Environmentally Assisted Cracking of Ferritic Structural Steels; (D) Fatigue of Austenitic Stainless Steels in LWR Environments; (E) Effect of Irradiation on SCC in Reactor Coolant Environments; and (F) Erosion-Corrosion in Safety-Related Piping Systems.

23726 (NUREG–0975-Vol.6, pp. 347-357) **Evaluation of nuclear facility decommissioning projects (ENFDP) program.** Tarcza, J.E. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering. Jun 1988. In *Compilation of contract research for the Materials Engineering Branch, Division of Engineering. Annual report for FY 1987.* Order Number DE88013182. Available from NTIS, PC A18/MF A01 - I.

The objective of this program is to provide the Nuclear Regulatory Commission (NRC) staff data which will allow an assessment of man-hours expended, radioactive wastes generated by type and volume, alternative methods of decommissioning and occupational doses incurred during decommissioning activities. The data provided will also include available cost information to assist the NRC in determining the proper amount of funds which must be available to ensure timely and safe decommissioning of facilities. Additionally detailed information on waste characterization from reactor decommissioning projects will provide support for regional waste compact guidance. The work effort for Fiscal Year (FY) 1987 was divided into three categories for proper activity definition and cost accounting. Those categories are: program management, collection of data, and analysis and reporting of field data.

23727 (NUREG–0975-Vol.6, pp. 358-374) **The impact of light-water reactor decontaminations on solidification, waste disposal, and associated occupational exposure.** Soo, P.; Adams, J.W.; Kempf, C.R. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering. Jun 1988. In *Compilation of contract research for the Materials Engineering Branch, Division of Engineering. Annual report for FY 1987.* Order Number DE88013182. Available from NTIS, PC A18/MF A01 - I.

During light-water reactor operation, components in the primary system become radioactive because of the deposition of corrosion products which are transported from the core regions by the coolant. In order to minimize worker exposure to radiation during routine maintenance operations, industrial procedures have been developed to chemically remove the corrosion products and the activity that they contain. After the corrosion products have been removed by organic reagents, the waste stream is passed through mixed (anion/cation) resin beds which remove residual reagent and the radioactive and non-radioactive ions in solution. The resins are either sealed in high-integrity containers or they may be solidified in cement, or some other matrix, in order to meet structural stability requirement specified in the NRC Technical Position on Waste Form (NRC, 1983). The current program is an effort to evaluate the solidification processes that are being used in industry for decontamination waste, and to determine how the wastes behave during on-site storage and subsequent disposal at a shallow-land burial site. Particularly important are the corrosion of container materials by spent resins, and resin degradation mechanisms which could lead to gas generation and pressurization of sealed containers. Another important consideration involves the potential for the cracking of cement-based decontamination waste forms by alternate freeze-thaw cycling. The freeze-thaw cycling effort is close to completion, the container corrosion work will continue for approximately one more year to obtain long-term performance data, and the resin degradation effort is currently being initiated.

23728 (NUREG–0975-Vol.6, pp. 389-401) **Radionuclide source term measurements for decommission assessments.** Robertson, D.E. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering. Jun 1988. In *Compilation of contract research for the Materials Engineering Branch, Division of Engineering. Annual report for FY 1987.* Order Number DE88013182. Available from NTIS, PC A18/MF A01 - I.

The objective of this project is to provide an up-to-date regulatory assessment of the radiological factors, criteria and problem areas associated with the technology, safety, and costs pertaining to reactor decommissioning and related waste disposal. This is being accomplished through a measurements and appraisal program focused in the following key areas: radiological characterization during Shippingport Station decommissioning; radiological characterization of intermediate-level wastes (highly activated reactor internal materials greater than Class C); evaluation of the accuracy of predictive activation codes and methods; and assessment of decommissioning waste disposal options.

23729 (NUREG–0975-Vol.6, pp. 375-388) **ESF system fission product retention effectiveness.** Kannberg, L.D.; Owczarski, P.C. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering. Jun 1988. In *Compilation of contract research for the Materials Engineering Branch, Division of Engineering. Annual report for FY 1987.* Order Number DE88013182. Available from NTIS, PC A18/MF A01 - I.

The objective of this research is to develop validated analytical models for use in estimating fission product retention effectiveness of light water reactor (LWR) engineered safety feature (ESF) systems. Program planning is directed toward reducing the highest priority uncertainties in severe accident/source term phenomena. Candidate ESF systems include spray, suppression pool, containment cooler, and containment and auxiliary air cleaning systems as well as the ice compartments of ice condenser containment systems. The work involves identifying, planning, and conducting experiments needed to validate models and providing guidelines for system design and operating and maintenance requirements. It also includes developing information that will not only identify the most important systems but will permit these systems to be emphasized in future regulatory processes. During FY 1987 work focused on activities related to the validation of the ICEDF and SPARC computer codes. The codes were developed at the Pacific Northwest Laboratory (PNL) to estimate the extent of fission product retention in the ice compartments of pressurized water reactor (PWR) ice condenser containment systems and boiling water reactor (BWR) suppression pools. Scope of the efforts related to ICEDF code validation ranged from construction of an engineering-scale test facility to the subsequent use of the facility for the conduct of experiments to obtain data for comparison with code calculations. Validation efforts associated with the SPARC code involved comparison of calculations from a modified version of the code with data from tests sponsored by the Electric Power Research Institute (EPRI). The ICEDF and SPARC codes were also used in support of several major NRC activities in FY 1987.

2102 Power Reactors, Nonbreeding, Light-Water Moderated, Nonboiling Water Cooled

Refer also to citation(s) 23541, 23582, 23725, 23726, 23727, 23728, 23729, 23741, 23772, 23773, 23774, 23775, 23778, 23779, 23782, 23783, 23784, 23785, 23786, 23787, 23788, 23789, 23790, 24358

23730 (CEA-DAS–619) **Evaluation of feed and bleed cooling mode in case of total loss of feedwater on 900 MWe PWR.** Champ, M. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (FR). Dept. d'Analyse de Surete); Cornille, Y. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete. Jul 1989. 14p. (CONF-8906307–: CSNI specialist meeting on intentional coolant system depressurization, Garching, DE (USA), 12-14 Jun 1989). Order Number DE90762040. Available from NTIS (US Sales Only), PC A03/MF A01.

The physical studies carried out with the CATHARE code to assess the feed and bleed procedure developed in order to cope with the total loss of feed water on a 900 MWe PWR are presented. These studies allowed the definition of the maximum delays of intervention which would prevent the core from uncovering. Different cases of equipment availability are considered. The data generated will be used in the 900 MWe Probabilistic Safety Assessment which is under way at the Institut de Protection et de Surete Nucleaire.

23731 (IWGFPT–27, pp. 19-43) **PWR fuel element behavior at temperatures up to 2350 deg. C.** Hagen, S. (Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Hauptabteilung Ingenieurtechnik); Hofmann, P. International Atomic Energy Agency, Vienna (Austria). International Working Group on Water Reactor Fuel Performance and Technology. Sep 1987. (CONF-8611109–: IAEA technical committee meeting on water reactor fuel behaviour and fission products release in off-normal and accident conditions, Vienna (Austria), 10-13 Nov 1986). In *Water reactor fuel behaviour and fission products release in off-normal and accident conditions: Proceedings of a technical committee meeting held in Vienna, 10-13 November 1986.* Order Number DE90621928. Available from NTIS (US Sales Only), PC A12/MF A01; OSTI; INIS.

Chemical interactions between UO_2 fuel and Zircaloy cladding up to 2350 deg. C is described. UO_2/Zircaloy single effects tests have been performed with short LWR fuel rod segments in inert gas and under oxidizing conditions. The reaction kinetics of molten Zircaloy cladding with solid UO_2 fuel has been investigated with UO_2 crucibles containing molten Zircaloy. The UO_2/Zircaloy reactions obey parabolic rate laws. The oxygen uptake by solid Zircaloy due to chemical interaction with UO_2 occurs nearly as quickly as in reactions with steam or oxygen. To study the competing effects of external and internal cladding oxidation under realistic boundary conditions and the influence of uncontrolled temperature escalation due to the exothermic steam/Zircaloy reaction, single-rod and bundle experiments have been performed. Electrically heated fuel rod simulators, including absorber rod material (Ag, In, Cd alloy), guide tubes and grid spacers are used. The maximum measured cladding temperature during the temperature escalation was about 2200 deg. C. The failure temperature of the absorber rods and the extent of bundle damage depends on the guide tube material (Zircaloy or stainless steel) and varies between 1200 and 1350 deg. C. The molten materials and liquid reaction products can relocate and form large coherent lumps on solidification, which may result in complete blockage of the fuel rod bundle cross section. In the future, 7x7 bundle experiments of 2 m overall length will be performed in the new CORA facility to study, in addition, the influence of quenching on fuel rod integrity. (author). 29 refs, 23 figs.

23732 (IWGFPT–27, pp. 51-53) **Chemical interactions in water-cooled nuclear fuel: a thermochemical approach.** Cordfunke, E.H.P. (Netherlands Energy Research Foundation, Petten (Netherlands)); Konings, R.J.M. International Atomic Energy Agency, Vienna (Austria). International Working Group on Water Reactor Fuel Performance and Technology. Sep 1987. (CONF-8611109–: IAEA technical committee meeting on water reactor fuel behaviour and fission products release in off-normal and accident conditions, Vienna (Austria), 10-13 Nov 1986). In *Water reactor fuel behaviour and fission products release in off-normal and accident conditions: Proceedings of a technical committee meeting held in Vienna, 10-13 November 1986.* Order Number DE90621928. Available from NTIS (US Sales Only), PC A12/MF A01; OSTI; INIS.

The release behaviour of the fission products in LWR is strongly influenced by their chemical state in the nuclear fuel as well in "off normal", steam containing environments. The present knowledge of the most likely chemical states is based on out of pile experiments, post irradiation experiments and thermochemical calculations. In our institute in Petten we have been engaged in an assessment of the thermochemical properties of all relevant compounds of the fission products. In addition, we have initiated an experimental program to measure the lacking thermochemical data, such as vapour pressures, enthalpies of formation and enthalpy increments above 298.15 K. The new data enable us now to predict the chemical behaviour of the fission products more accurately. 2 figs, 2 tabs.

23733 (IWGFPT–27, pp. 98-108) **Characteristics of corrosion behaviour of Zr1%Nb WWER fuel cladding within 700-1000 deg. C on long term exposures.** Solyany, V.I. (Vsesoyuznyj Nauchno-Issledovatel'skij Inst. Neorganicheskikh Materialov, Moscow (USSR)); Bibilashvili, Yu.K.; Dranenko, V.V.; Izrailevskij, L.B.; Levin, A.Ya.; Morozov, A.A. International Atomic Energy Agency, Vienna (Austria). International Working Group on Water Reactor Fuel Performance and Technology. Sep 1987. (CONF-8611109–: IAEA technical committee meeting on water reactor fuel behaviour and fission products release in off-normal and accident conditions, Vienna (Austria), 10-13 Nov 1986). In *Water reactor fuel behaviour and fission products release in off-normal and accident conditions: Proceedings of a technical committee meeting held in Vienna, 10-13 November 1986.* Order Number DE90621928. Available from NTIS (US Sales Only), PC A12/MF A01; OSTI; INIS.

This paper describes some results of corrosion tests carried out to investigate corrosive interaction between Zr-1%Nb cladding and water steam in accident conditions, in the temperature range of 700 to 1500 deg. C. The curves of weight gain vs. time showed multiple transitions. The influence of temperature changes on the mode and kinetics of oxidation is being analyzed. (author). 2 refs, 10 figs.

23734 (IWGFPT–27, pp. 140-162) **Analysis of fission gas release from UO_2 fuel during power transients by FEMAXI-IV code.** Nakajima, T. (Japan Atomic Energy Research Inst., Ibaraki (Japan)); Saito, H. International Atomic Energy Agency, Vienna (Austria). International Working Group on Water Reactor Fuel Performance and Technology. Sep 1987. (CONF-8611109–: IAEA technical committee meeting on water reactor fuel behaviour and fission products release in off-normal and accident conditions, Vienna (Austria), 10-13 Nov 1986). In *Water reactor fuel behaviour and fission products release in off-normal and accident conditions: Proceedings of a technical committee meeting held in Vienna, 10-13 November 1986.* Order Number DE90621928. Available from NTIS (US Sales Only), PC A12/MF A01; OSTI; INIS.

FEMAXI-IV is a computer code to analyze the thermal and mechanical behaviour of a fuel rod during steady-state and transient conditions. In FEMAXI-IV, the time-dependent models are used for heat conduction, fission gas release, and mixing of the released gas with the plenum gas. The fission gas release model, involved in FEMAXI-IV, takes into account the following mechanisms: diffusion of gas atoms to the grain boundary considering the effect of trapping at intragranular bubbles, sweeping of gas atoms by grain growth, resolution of gas atoms into the grain interior from grain boundary bubbles, and fission gas release due to bubble interconnection. The release of fission gas during transient condition is accelerated by the grain boundary sweeping and the rapid, long-range interconnection of porosity. On the other hand the transient release of fission gas to the gap volume causes a contamination of filler gas in the gap and hence high fuel temperature until the released gas is diluted with the filler gas in the plenum. Such fission gas behavior during transient condition was analyzed by FEMAXI-IV code and calculations were compared with the fission gas release data obtained in the power th power ramp experiments. This paper summarizes the models involved in FEMAXI-IV and the results of calculations on the experimental data. (author). 19 refs, 27 figs, 7 tabs.

23735 (NUREG–0975-Vol.6, pp. 211-240) **Surry steam generator integrity program/steam generator group project.** Kurtz, R.J. (Pacific Northwest Lab., Richland, WA (USA)); Bickford, R.L.; Bowen, W.M.; Bradley, E.R.; Doctor, P.G.; Ferris, R.H.; Fetrow, L.K.; Simonen, F.A. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering. Jun 1988. In *Compilation of contract research for the Materials Engineering Branch, Division of Engineering. Annual report for FY 1987.* Order Number DE88013182. Available from NTIS, PC A18/MF A01 - I.

The principal objectives of this program were to assess the effectiveness of Regulatory Guides 1.83 and 1.121 to (1) define the procedure for conducting nondestructive in-service inspections (ISIs) of steam generator tubing, and (2) determine plugging limits of service-degraded tubing under normal operating and accident loading conditions. To reach these objectives, the program utilized a retired-from-service steam generator from the Surry 2 Nuclear Station. Nondestructive (NDE) and destructive examinations of the generator provided information on the accuracy of conventional eddy current and developmental inspection methods to characterize flaws in steam generator tubing. In addition, burst testing of laboratory and service defected tubing was performed to validate models of remaining tube integrity developed previously. The FY 1987 work scope included: (1) complete removals of steam generator tube, tube sheet and support structure specimens; (2) complete nondestructive and destructive characterizations on removed-from-generator specimens to validate the inspection results; (3) complete bursts testing at operating temperature of removed-from-generator and laboratory defected tube segments containing defects; (4) evaluate and compare candidate sampling plans for ISI of steam generators; (5) evaluate and compare candidate tube plugging criteria; (6) save representative degraded tube specimens for a simple library; (7) make the generator available for demonstration and evaluation of steam generator repair techniques; (8) issue a questionnaire and prepare a report on international practice for plugging, repair and inspection of steam generator tubing and (9) complete decommissioning of the steam generator examination facility.

23736 (ZfK–628) **Investigations of the loadability of WWER fuel rods.** Boehmert, J.; Luebke, L.; Reinfried, D. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1987. 14p. (In German). Order Number DE90621916. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Two simply applicable criteria are suggested for the estimation of the loadibility of a fuel rod especially under power ramping conditions: the maximum tangential tensile stress in the case of iodine stress corrosion cracking, and the tangential uniform elongation. The influence of temperature, strain rate, strain history, irradiation, and stress state on these criteria are analysed. Irradiation proves to be the decisive process causing a strong reduction of load limits already during the first cycle of operation. Tangential stresses and strains occuring in the cladding are calculated by means of the one-dimensional integral fuel rod performance modelling code STOFFEL-1. These values are correlated with the determined load limits. Thus a failure threshold is obtained for the permissible increase of fuel rod power in dependence on burnup. The failure threshold agrees with results of Studsvik's international power ramp test projects. It indicates the good power ramping performance of WWER fuel rods. A first experimental corroboration was obtained by simulation experiments. (author).

2103 Power Reactors, Nonbreeding, Graphite Moderated

Refer also to citation(s) 23582, 23776, 23780, 23781

2104 Power Reactors, Nonbreeding, Otherwise Moderated or Unmoderated

Refer also to citation(s) 23740

23737 (BARC–1456) **A report on stress analysis of seal disc of 235 MWe PHWR.** Chawla, D.S. (Bhabha Atomic Research Centre, Bombay (India). Reactor Engineering Div.); Dutta, B.K.; Kushwaha, H.S.; Kakodkar, A.; Sanatkumar, A. Bhabha Atomic Research Centre, Bombay (India). 1989. 4p. Order Number DE90621956. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The seal disc is an important component of pressurized heavy water reactor. When mounted, this becomes a part of the coolant channel and hence is a pressure boundary for the heavy water coolant inside the channel. Detailed stress analysis of seal disc of 235 MWe PHWR (MAPP) is done. Linear elastic analysis showed that stresses are more than the allowable values as per ASME code Section III, Division 1. This makes it necessary to invoke the special provision of MB-3228.1 (1986). An elasto-plastic analysis was done to find out the collapse load which showed that the seal disc is safe for all stages of loadings. (author). 2 tabs., 7 figs.

2105 Power Reactors, Breeding

Refer also to citation(s) 23741, 23756

2106 Power Reactors, Auxiliary, Mobile, Package, and Transportable

Refer also to citation(s) 23792

23738 (N–90-14279) **Electrical performance characteristics of high power converters for space power applications. Final report, 1 January 1988-30 September 1989.** Stuart, T.A.; King, R.J. Toledo Univ., OH (USA). Sep 1989. 149p. (NASA-CR–185947;NAS–1.26:185947). Available from NTIS, PC A07/MF A01.

The first goal of this project was to investigate various converters that would be suitable for processing electric power derived from a nuclear reactor. The implementation is indicated of a 20 kHz system that includes a source converter, a ballast converter, and a fixed frequency converter for generating the 20 kHz output. This system can be converted to dc simply by removing the fixed frequency converter. This present study emphasized the design and testing of the source and ballast converters. A push-pull current-fed (PPCF) design was selected for the source converter, and a 2.7

kW version of this was implemented using three 900 watt modules in parallel. The characteristic equation for two converters in parallel was derived, but this analysis did not yield any experimental methods for measuring relative stability. The three source modules were first tested individually and then in parallel as a 2.7 kW system. All tests proved to be satisfactory; the system was stable; efficiency and regulation were acceptable; and the system was fault tolerant. The design of a ballast-load converter, which was operated as a shunt regulator, was investigated. The proposed power circuit is suitable for use with BJTs because proportional base drive is easily implemented. A control circuit which minimizes switching frequency ripple and automatically bypasses a faulty shunt section was developed. A nonlinear state-space-averaged model of the shunt regulator was developed and shown to produce an accurate incremental (small-signal) dynamic model, even though the usual state-space-averaging assumptions were not met. The nonlinear model was also shown to be useful for large-signal dynamic simulation using PSpice.

2107 Regulation and Licensing

Refer also to citation(s) 23735, 23776, 23780, 23783, 23789

2108 Economics

Refer also to citation(s) 23727

22 NUCLEAR REACTOR TECHNOLOGY

23739 (DOE/NE/37944–1) **Technical specifications requirements: Automated reasoning applications: Final report.** Lidsky, L.M.; Dobrzeniecki, A.B. Massachusetts Inst. of Tech., Cambridge, MA (USA). Mar 1990. 13p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC02-85NE37944. Order Number DE90008799. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Several software systems were developed and tested to determine what advantages could be gained from explicitly translating complicated regulatory requirements into computerized relationships. The Technical Specifications for US nuclear power plants were chosen as the test-bed application domain, and two analysis systems were developed to monitor plant compliance with operational limits, and track and schedule equipment test and maintenance activities mandated by Technical Specifications. Choosing PROLOG as the computer language to represent these regulatory requirements resulted in a natural match between the semantic structure of the written specifications and the corollary coded rules. Additional research results affirmed the utility of declarative programming styles, explicit management of problem complexity, and attention to the robustness and flexibility of the overall software systems. 5 refs., 2 figs.

2201 Theory and Calculation

Refer also to citation(s) 23542, 23556, 23557, 23558

23740 (BARC–1452) **Point kinetics model with one-dimensional (radial) heat conduction formalism.** Jain, V.K. (Bhabha Atomic Research Centre, Bombay (India). Theoretical Physics Div.). Bhabha Atomic Research Centre, Bombay (India). 1989. 18p. Order Number DE90621899. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A point-kinetics model with one-dimensional (radial) heat conduction formalism has been developed. The heat conduction formalism is based on corner-mesh finite difference method. To get average temperatures in various conducting regions, a novel weighting scheme has been devised. The heat conduction model has been incorporated in the point-kinetics code MRTF-FUEL. The point-kinetics equations are solved using the method of real integrating factors. It has been shown by analysing the simulation of hypothetical loss of regulation accident in NAPP reactor that the model is superior to the conventional one in accuracy and speed of computation. (author). 3 refs., 3 tabs.

23741 (BARC–1463) **HEXG - a centre mesh finite difference code to solve multigroup diffusion equations in two dimensional hexagonal geometry.** Jagannathan, V. (Bhabha Atomic Research Centre, Bombay (India). Reactor Analysis and Systems Div.); Jain, R.P. Bhabha Atomic Research Centre, Bombay (India). 1989. 32p. Order Number DE90621900. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

For analysing the hexagonal reactor by multigroup diffusion theory a two dimensional finite difference code HEXG has been written. Mesh-centred finite difference scheme with hexagonal meshes gives rise to seven point coupling. One can consider 30deg, 60deg, 90deg, 120deg symmetry in addition to a full core treatment. HEXG can be used for analysis of a single fuel assembly with reflective boundary conditions on all sides. One can also perform a detailed core analysis with single fuel pin representation wherein the external boundary condition is either xero flux or vacuum boundary. The solution method is point successive over relaxation (PSOR) with a generalised coarse mesh rebalancing (CMR) acceleration scheme for the inner loop of iterations. HEXG is used for determining the eigenvalue or K-effective, flux, adjoint flux and power distributions in hexagonal lattice/core configurations. (author). 14 refs., 5 tabs., 8 figs.

23742 (CEAC-R–6-89) **Organization of an interphase system for the coupling of WINS-D4 and SNAP-3D programs.** Frias Suarez, D. (Instituto Superior de Ciencia y Tecnologia Nuclear, La Habana (Cuba)). Comision de Energia Atomica, La Habana (Cuba). 1989. 26p. (In Spanish). Order Number DE90622146. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In this report a modular system developed for the CC-1 critical assembly's physical calculation is described. It was based upon the WINS-D4 and SNAP-3D codes, which are coupled by means of an interphase module and a groups diffusion cross sections library.

23743 (CONF-900343–6) **Position note for supercomputing for design of nuclear facilities.** Knee, H.E. Oak Ridge National Lab., TN (USA). [1990]. 4p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. From Supercomputing in nuclear applications; Mito City (Japan); 12-16 Mar 1990. Order Number DE90008754. Available from NTIS, PC A02/MF A01 - OSTI.

During the past decade, developments that have emerged in the area of supercomputing technologies have provided a new potential with respect to design. First, supercomputing technologies have provided means for the development of new design tools and environments that may be utilized for more optimal designs. Second, supercomputing technologies themselves are being utilized within particular designs as a means for realizing more optimal systems. The potential impact of supercomputing power is just beginning to be perceived, and is just starting to be assimilated into industrial environments. With regard to the nuclear industry and supercomputing: the commercial industry within the US seems to have been relatively slow (if not stagnant) to embrace such technologies. This is not surprising given the relatively stringent regulatory environment within the US, and the lack of motivation (by the regulatory agencies and the utilities) to introduce advanced instrumentation, controls, or supercomputing capabilities into the industry. Although the US commercial nuclear industry has demonstrated a relative paucity with respect to the use of advanced technologies (advanced instrumentation and controls [I&C], including supercomputing), there has been some relatively creative utilization of such technologies with respect to new advanced reactor design concepts, and within the design process itself.

23744 (SAND–89-0018, pp. 147-154) **Reactor physics and design code issues.** Westfall, R.M. (Oak Ridge National Lab., TN (USA)). Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

Reactor physics methodology required for burnup credit is drawn from two major areas of analytical endeavor. The isotopic composition of the spent fuel is determined through reactor burnup analyses. The reactivity worth of the spent fuel in a particular cask

design configuration is determined through cask criticality analyses. The purpose of this paper is to provide a brief introduction to potential issues involved in characterizing spent fuel and its reactivity worth, and to provide a brief review of major design code packages which are suitable for performing these analyses. A more detailed discussion of the point-reactor burnup and criticality methodologies is given. A general exposition of multidimensional reactor-burnup methodology as practiced in the power reactor industry is also presented.

23745 (SAND–89-0018, pp. 163-165) **Summary - COG: A new point-wise Monte Carlo code for burnup credit analysis.** Alesso, H.P. (Lawrence Livermore National Lab., CA (USA)). Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

COG, a new point-wise Monte Carlo code being developed and tested at Lawrence Livermore National Laboratory (LLNL) for the Cray-1, solves the Boltzmann equation for the transport of neutrons, photons, and (in future versions) other particles. Techniques included in the code for modifying the random walk of particles make COG most suitable for solving deep-penetration (shielding) problems and a wide variety of criticality problems. COG is similar to a number of other computer codes used in the shielding community. Each code is a little different in its geometry input and its random-walk modification options. COG is a Monte Carlo code specifically designed for the CRAY (in 1986) to be as precise as the current state of physics knowledge. It has been extensively benchmarked and used as a shielding code at LLNL since 1986, and has recently been extended to accomplish criticality calculations. It will make an excellent tool for future shipping cask studies.

23746 (SAND–89-0018, pp. 167-177) **An uncertainty analysis - Axial burnup distribution effects.** Turner, S.E. (Holtec International, Palm Harbor, FL (USA)). Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

Regulatory Guide 1.13, Revision 2, was issued for comment in December 1981, but has not yet been formally adopted and issued. Nevertheless, some of the principles in the proposed version are being used today in the licensing of spent fuel storage racks, in particular the sections allowing credit for fuel burnup. One of the requirements of draft Regulatory Guide 1.13, given in Appendix A, is the following: Consideration should be given to the axial distribution of burnup in the fuel assembly and a limit should be set on the length of the fuel assembly that is permitted to have a lower average burnup than the fuel assembly average. It is the reactivity effect - or uncertainty - due to the axial burnup distribution that is presented here. For shipping casks or in dry cask storage, the axial burnup distribution would, at least qualitatively, have an effect similar to that for PWR fuel. The present discussion is concerned primarily with PWR fuel. Based on these preliminary evaluations, the following conclusions can be made: (1) the axial distribution in burnup can make a significant contribution ~1 or 2% δk to reactivity calculations when credit for burnup is desired; (2) the reactivity effect of an axial burnup distribution is dependent upon both the shape of the distribution and the discharge burnup; (3) additional work is needed to better define and understand the shape of the axial burnup distribution, especially for the steep gradient in burnup near the top of the fuel assemblies; (4) the decrease in reactivity with cooling time may be an important consideration even if only to indicate an increasing margin of safety.

23747 (SAND–89-0018, pp. 197-201) **General philosophy on fuel management for burnup credit application.** Jones, R.H. Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

It has become clear to many of those who have studied burnup credit applications that one of the keys to the acceptance of this design consideration is fuel management. Few doubt the physics of reduced reactivity as a result of fission product poisoning and fissile material depletion. And clearly, few question our current or future ability to predict the k_{eff} of a fuel array within a cask. At issue is our confidence in the fuel management systems of the nuclear utilities that ensure that specification fuel is loaded into the cask or, perhaps more correctly, the items that assure that non-specification fuel is not loaded into the cask. Non-specification is defined here as fresh or burned fuel with reactivity that exceeds the cask design basis. Incidentally, this definition should apply equally to burnup credit as it does to the fresh fuel assumption since misloading errors can occur in either case, although the probabilities of such occurrences are extremely low.

23748 (SAND–89-0018, pp. 249-261) **In-core methods for verifying fuel assembly burnup.** Napolitano, D. (Yankee Atomic Electric Co., Bolton, MA (USA)). Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

Traditionally, utilities have used in-core measurement systems to determine power distribution and assembly burnup. In addition, core reactivity can be inferred from boron letdown curves, critical rod inventories, and startup physics test measurements. It is the objective of this paper to survey in-core measurement systems, and to show that this information can be used to quantify fuel assembly burnup for application to burnup credit in fuel storage and transportation. In addition, the impact of burnup credit use on plant Technical Specifications and refueling operations is discussed. A sufficient amount of in-core information is available to provide assembly burnup and/or reactivity. The present systems can be modified to give greater axial detail, if necessary. A clear elaboration of spent fuel pool Technical Specifications is necessary if burnup credit is implemented for transport casks. An extension of the two region, spent fuel pool becomes apparent in which the transport cask becomes a third region and in which a burnup versus enrichment trade-off curve must be specified. In addition, criticality safety training for refueling personnel must be emphasized and extended to include the burnup credit concept and also to preclude the misplacement of fresh assemblies in the burnup credit areas.

23749 (SAND–89-0018, pp. 263-284) **Measurements to establish burnup credit for spent fuel assemblies.** Goldstein, N.P. (Westinghouse R and D Center, Pittsburgh, PA (USA)). Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC–0884;CONF-880251–: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

This paper describes a burnup meter which measures the integrated flux exposure (rather than actual burnup) of spent fuel assemblies. If measurements become required in order to take credit for burnup, then the burnup meter could play an important role in providing this capability. Measurements can be brought into the process in two ways, either through verification or through blind measurements. In the verification method an assembly would be accepted for dense storage through its administrative data and the measurements would be used to verify the identity of the assembly. In the blind measurements the acceptance of an assembly for dense storage would be made directly from the measurement independent of its identity or its associated administrative data. In this paper the characteristics of the burnup meter are described and the results of a field test which demonstrated its ease of use and accuracy are reported. Finally, the use of the burnup meter in the two measurement roles described in the previous paragraph and its comparison with two other measurement methods (true burnup

and k_{eff}) is also discussed. Of these the burnup meter is the simplest to use and provides the most accurate data for verification. On the other hand, the k_{eff} methods are best suited for the blind measurements, while the burnup meter provides conservative but still useful data in this measurement mode.

23750 (ZfK–641) **Monte Carlo calculation of the reactivity effect of small material samples.** Seifert, E. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1988. 18p. (In German). Order Number DE90621432. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A Monte Carlo method for the calculation of the reactivity effect of small material samples in a nuclear reactor is given. The calculational effort is reduced by a proper use of precalculated results of the unperturbed system (without the sample) with the help of deterministic methods. The method is realized in a computer code PROREX on the BESM-6 computer. Some examples of application show the possibilities and limitations of the method. A statistical accuracy of about 1% is obtainable for many sample isotopes. This is not so for the important structural materials (e.g. the steel components). For this faster computers than the BESM-6 are necessary. (author).

2202 Components and Accessories

Refer also to citation(s) 23737, 23771, 23941, 24155, 25191

23751 (CLM-R–292) **Turbulence modelling in naturally convecting fluids.** Lawrence, S.P. UKAEA Culham Lab., Abingdon (UK). Sep 1989. 46p. Available from H.M. Stationery Office, London, price Pound 10.00. Available from H.M. Stationery Office, London, price Pound 10.00.

In this report an introduction to turbulence modelling is presented, with applications to heat transfer in a molten pool. The turbulence closure problem is discussed and some approximations and methods are given for determining certain unknowns in the transport equations. Three methods of closure are given. These are: the k - ϵ model; the algebraic-stress model and the full Reynolds Stress model, this last being the most general of the three. Finally, we apply two of these closures to the problem of a strongly convective flow. We show that these provide a turbulent solution in the limit of steady-state and no mean flow. However, it is an open question as to whether the physics of a strongly convective flow can be realistically modelled by such closures. (author).

23752 (NUREG/CR–5511) **Irradiation effects on strength and toughness of three-wire series- arc stainless steel weld overlay cladding.** Haggag, F.M.; Corwin, W.R.; Nanstad, R.K. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Oak Ridge National Lab., TN (USA). Feb 1990. 155p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. (ORNL/TM–11439). Available from NTIS, PC A07/MF A01 - GPO; OSTI; INIS.

The potential for stainless steel cladding to improve the fracture behavior of an operating nuclear reactor pressure vessel, particularly during certain overcooling transients, may depend greatly on the properties of the irradiated cladding. Therefore, three-wire stainless steel cladding irradiated at temperatures and to fluences relevant to power reactor operation was examined. Postirradiation tensile testing results show that, in the test temperature range from −125 to 288°C, the yield strength increased by 8 to 30%, ductility increased insignificantly, with almost no change in ultimate tensile strength. All cladding exhibited ductile-to-brittle transition behavior during Charpy impact testing, because of the dominance of delta ferrite failures at low temperatures. On the upper shelf, energy was reduced 15 and 20%, while the lateral expansion was reduced 43 and 41%, owing to irradiation exposure of 2 and 5×10^{19} neutrons/cm^2 (>1 MeV), respectively. In addition, radiation damage resulted in 13 and 28°C shifts of the Charpy impact transition temperature at the 41-J level for the low and high fluences, respectively. Furthermore, irradiation exposure of 12.5-mm-thick compact specimens (0.5TCS), to an average fluence of 2.41×10^{19} neutrons/cm^2 (>1 MeV), resulted in decreases in the initiation fracture toughness, J_{Ic}, and the tearing modulus in the test temperature range. This is in agreement with the reduction in both the Charpy V-notch upper-shelf energy and the lateral expansion. 14 refs., 26 figs., 13 tabs.

23753 (ZfK–662) **Design of experiments for test of fuel element reliability.** Boehmert, J.; Juettner, C.; Linek, J. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1989. 13p. (In German). Order Number DE90621907. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Changes of fuel element design and modifications of the operational conditions have to be tested in experiments and pilot projects for nuclear safety. Experimental design is an useful statistical method minimizing costs and risks for this procedure. The main problem of our work was to investigate the connection between failure rate of fuel elements, sample size, confidence interval, and error probability. Using the statistic model of the binomial distribution appropriate relations were derived and discussed. A stepwise procedure based on a modified sequential analysis according to Wald was developed as a strategy of introduction for modifications of the fuel element design and of the operational conditions. (author).

2203 Fuel Elements

Refer also to citation(s) 23539, 23794

23754 (IWGFPT–27, pp. 66-75) **Chemical interaction of Zircaloy tubing with UO_2 fuel and steam at temperatures between 1000 deg. C and 2000 deg. C. Verification of the PECLOX code.** Garcia, E.A. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina). Dept. de Materiales); Hofmann, P.; Neitzel, H.J. International Atomic Energy Agency, Vienna (Austria). International Working Group on Water Reactor Fuel Performance and Technology. Sep 1987. (CONF-8611109–: IAEA technical committee meeting on water reactor fuel behaviour and fission products release in off-normal and accident conditions, Vienna (Austria), 10-13 Nov 1986). In *Water reactor fuel behaviour and fission products release in off-normal and accident conditions: Proceedings of a technical committee meeting held in Vienna, 10-13 November 1986.* Order Number DE90621928. Available from NTIS (US Sales Only), PC A12/MF A01; OSTI; INIS.

In a SFD (Severe Fuel Damage) accident the Zircaloy-4 (Zry) cladding material will interact with the UO_2-fuel on the internal cladding surface and with steam on the external cladding surface. These reactions result in the formation of ZrO_2, various oxygen-stabilized α-Zr(O) phases and a (U,Zr) alloy. The internal UO_2/Zry interaction can be considered as oxidation of Zry by reaction with a solid oxide (UO_2). The reaction becomes significant at temperatures about 1000 deg. C, if a good solid contact between cladding and fuel exists. Two codes have been developed to describe the internal and external Zry cladding oxidation. One is the PECLOX code and the other one is the HITO code. Both of them use finite difference methods to solve the oxygen diffusion equation in the various reaction layers; the first one is in the explicit version and the second one in the implicit version. In this work, experimental results of isothermal and temperature transients reaction experiments are used to test the PECLOX code. Both types of experiments include transient interactions that mean the formation of reaction layers during heatup and cooldown. Comparison with isothermal tests shows that PECLOX - with an adequate set of material properties data (oxygen diffusion coefficients, concentrations at the interfaces, etc.) - gives a good description of the combined internal and external Zry oxidation. The advantages and the further improvements of the PECLOX code are described and discussed. 12 refs, 13 figs.

2204 Control Systems

23755 (CEAC-R–1-89) **Effectiveness of the mechanical regulation system of the First Block Juragua Nuclear Power Plant.** Garcia Hernandez, C.R. (Instituto Superior de Ciencia y Tecnologia Nuclear, La Habana (Cuba)); Diaz, P. Comision de Energia Atomica, La Habana (Cuba). 1989. 5p. (In Spanish). Order Number DE90621918. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

In this report the most important calculated values of the control rods integral and differential effectivity are shown for the Juragua

Nuclear Power Plant (First reactor-turbine unit), at the beginning and the end of the first and seventh cycle, supposing the design fuel arrangement.

23756 (CONF-900143–30) **Sequential probability ratio tests for reactor signal validation and sensor surveillance applications.** Humenik, K. (Maryland Univ., Baltimore, MD (USA)); Gross, K.C. Argonne National Lab., IL (USA). 9 Nov 1989. 27p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From Institute for Electronic and Electrical Engineers (IEEE) nuclear science symposium; San Francisco, CA (USA); 15-19 Jan 1990. Order Number DE90007797. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper examines the properties of sequential probability ratio tests (SPRT's) and the application of these tests to nuclear power reactor operation. Recently SPRT's have been applied to delayed-neutron (DN) signal data analysis using actual reactor data from the Experimental Breeder Reactor-II, which is operated by Argonne National Laboratory. The implementation of this research as part of an expert system is described. Mathematical properties of the SPRT are investigated, and theoretical results are validated with tests that use DN-signal data taken from the EBR-II in Idaho. Variations of the basic SPRT and applications to general signal validation are also explored. 16 refs., 3 figs.

2205 Environmental Aspects

Refer also to citation(s) 23569, 24358, 24723

23757 (DOE-RW–89.094) **Means of surveying contaminated areas resulting from overseas nuclear accidents.** Looney, J.H.H. (Electrowatt Engineering Services Ltd., Horsham (UK)); Thorne, M.C.; Dickson, D.M.J. Department of the Environment, London (UK). Sep 1989. 292p. Contract PECD-7/9/472. (EWE–2650.3). Order Number DE90621687. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The Chernobyl accident is briefly reviewed as a useful basis to examine some of the considerations related to the design of surveys. The plans and procedures of key European and North American countries are reviewed, as well as the plans and capabilities of UK facilities and government agencies. The survey design incorporates the concepts of land use category, topography climate, etc. and discusses the spatial and temporal scale requirements. Use of a Geographic Information System is recommended to co-ordinate the data. Models address the requirement to detect an annual effective dose equivalent of 0.5 mSv to an individual in the first year following the accident. The equipment requirements are based on transit-type vans, each, preferably, with one or two gamma spectrometers, MCA's and ancillary equipment, with three teams of two men. This unit could survey about 150 km^2 within a larger area in 3 days. The cost per survey team is estimated to be Pound 60,000 - Pound 80,000 in the first year, with annual costs of Pound 20-23,000. (author).

23758 (FRNC-TH–3494) **Principle and methodology of nuclear power plant site selection. Application to radiocobalt cycle in the Rhone river.** Georges, J. Montpellier-1 Univ., 34 (France). 1987. 176p. (In French). Order Number DE90762018. Available from NTIS (US Sales Only), PC A09/MF A01.

In a first bibliographic part, after some generalities on radioactivity and nuclear power, general principles of radiation protection and national and international regulations are presented. The methodology of the radioecological study involved in site selection is developed. In a second more experimental part, the processing of radiocobalt gamma radioactivity measurement in water, fishes, plants and Rhone river sediments demonstrates the influence of age and geographical situation of the nuclear power stations located along the river. A laboratory experiment of cobalt 60 transfer from chironomes larvae to carp is carried out. Comparison with the results of other laboratory experiments makes it possible to propose an experimental model of cobalt transfer within a fresh water ecosystem; radioactivity levels calculated for various compartments seem to be consistent with the Rhone river levels.

2206 Research, Test, and Experimental Reactors

Refer also to citation(s) 23756, 23769, 23770, 23777, 24157

23759 (ANL/RERTR/TM–9, pp. 3-13) **The RERTR [Reduced Enrichment Research and Test Reactor] program: A progress report.** Travelli, A. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

The progress of the Reduced Enrichment Research and Test Reactor (RERTR) Program is described. After a brief summary of the results which the RERTR Program, in collaboration with its many international partners, and achieved by the end of 1985, the activities, results, and new developments which occurred in 1986 are reviewed. The second miniplate series, concentrating on U_3Si_2-Al and U_3Si-Al fuels, was expanded and its irradiation continued. Postirradiation examinations of several of these miniplates and of six previously irradiated U_3Si_2-Al full-size elements were completed with excellent results. The whole-core ORR demonstration with U_3Si_2-Al fuel at 4.8 g U/cm^3 is well under way and due for completion before the end of 1987. The US DOE removed an important barrier to conversions by announcing that the new low-enrichment uranium (LEU) fuels will be accepted for reprocessing. New DOE prices for enrichment and reprocessing services were calculated to have minimal effect on high-enrichment uranium (HEU) reactors, and to reduce by about 8-10% the total fuel cycle costs of LEU reactors. New program activities include preliminary feasibility studies of LEU use in DOE reactors, evaluation of the feasibility to use LEU targets for the production of fission-product ^{99}Mo, and responsibility for coordinating safety evaluations related to LEU conversions of US university reactors, as required by NRC. Achievement of the final program goals is projected for 1990. This progress could not have been achieved without close international cooperation, whose continuation and intensification are essential to the achievement of the ultimate goals of the RERTR Program.

23760 (ANL/RERTR/TM–9, pp. 14-21) **Status of reduced enrichment program for research and test reactor fuels in Japan.** Kanda, Keiji (Kyoto Univ., Osaka (Japan)); Shibata, Toshikazu; Iso, Yasuhiko; Sakurai, Hiroshi; Okamoto, Yoshizo. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

The reduced enrichment program for the JRR-2, JRR-3, JRR-4 and JMTR of Japan Atomic Energy Research Institute (JAERI), and the KUR and KUHFR of Kyoto University Research Reactor Institute is in progress under the Joint Study Programs with Argonne National Laboratory. The feasibility study for use of low enriched uranium in the JMTR and KUR is under way. Several fuel irradiation tests are completed or in progress in JAERI. The Science Technology Agency of the Japanese Government organized two investigation committees for standardization of fuel fabrication and inspection for research and test reactors.

23761 (ANL/RERTR/TM–9, pp. 31-41) **Conversion and standardization of university reactor fuels using low-enrichment uranium (LEU) plans and schedules.** Young, H.H. (Department of Energy, Washington, DC (USA)); Brown, K.R.; Matos, J.E. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

The highly-enriched uranium (HEU) fuel used in twenty United States university reactors can be viewed as contributing to the risk of theft or diversion of weapons-useable material. The minimize this risk, the US Nuclear Regulatory Commission issued its final rule on Limiting the Use of Highly Enriched Uranium in Domestically Licensed Research and Test Reactors, in February 1986. This paper describes the plans and schedules developed by the US Department of Energy to coordinate an orderly transition from HEU to

LEU fuel in most of these reactors. An important element in the planning process has been the desire to standardize the LEU fuels used in US university reactors and to enhance the performance and utilization of a number of these reactors. The program is estimated to cost about $10 million and to last about five years.

23762 (ANL/RERTR/TM–9, pp. 64-79) **Preliminary investigations for technology assessment of ^{99}Mo production from LEU targets.** Vandegrift, G.F.; Chaiko, D.J.; Heinrich, R.R.; Kucera, E.T.; Jensen, K.J.; Poa, D.S.; Rajan, J.B.; Varma, R.; Vissers, D.R. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

This paper presents the results of preliminary studies on the effects of substituting low enriched uranium (LEU) for highly enriched uranium (HEU) in targets for the production of fission product ^{99}Mo. Issues that are addressed include: (1) purity and yield of the ^{99}Mo/^{99m}Tc product, (2) fabrication of LEU targets and related concerns, and (3) disposal of radioactive waste. Laboratory experimentation was part of the efforts for issues (1) and (2); thus far, radioactive waste disposal has only been addressed in a paper study. Although the reported results are still preliminary, there is reason to be optimistic about the feasibility of utilizing LEU targets for ^{99}Mo production.

23763 (ANL/RERTR/TM–9, pp. 173-182) **Effect of changes in DOE pricing policies for enrichment and reprocessing on research reactor fuel cycle costs.** Matos, J.E.; Freese, K.E. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

Fuel cycle costs with high-enrichment uranium (HEU) and low-enrichment uranium (LEU) fuels for the IAEA generic 10 MW reactor are updated to reflect the change in DOE pricing policy for enrichment services as of October 1985 and the published charges for LEU reprocessing services as of February 1986. The net effects are an increase of about 3% in HEU fuel cycle costs and a reduction of 2-3% in the fuel cycle costs for LEU silicide fuel.

23764 (ANL/RERTR/TM–9, pp. 259-266) **Final results from TRIGA LEU fuel post-irradiation examination and evaluation following long term irradiation testing in the ORR.** Simnad, M.T. (Univ. of California, San Diego (USA)); Copeland, G.L.; West, G.B. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

The qualification testing of TRIGA-LEU (U-ZrH) fuels to high burnups in the ORR has been completed successfully over a 5-yr period. These fuels have included loadings of 20 wt %, 30 wt %, and 45 wt % uranium; 19.7% enriched. The irradiated fuel rods have been subjected to a comprehensive PIE following burnups of up to 64% of the U-235, exposures of 919 FPD and fast neutron fluences of 5×10^{21} n/cm^2. No limiting values were reached on fuel burnup. Fuel growth was as predicted. Evidence was shown of limited thermal migration of hydrogen. There was no pressure buildup inside the cladding. Fission product release from highly burned fuel doesn't appear to be significantly different from fresh fuel. The results have demonstrated that these fuels will retain their integrity to burnups well in excess of the design goals.

23765 (ANL/RERTR/TM–9, pp. 332-341) **Flux wire measurements in Cavalier for verifying computer code applications.** Fehr, M. (Univ. of Virginia, Charlottesville (USA)); Stubbs, J.; Hosticka, B. Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

The Cavalier and UVAR research reactors are to be converted from high-enrichment uranium (HEU) to low-enrichment uranium (LEU) fuel. As a first step, an extensive set of gold wire activation measurements has been taken on the Cavalier reactor. Axial traverses show internal consistency to the order of ±5%, while horizontal traverses show somewhat larger deviations. The activation measurements will be converted to flux measurements via the Thermos code and will then be used to verify the Leopard-2DB codes. The codes will ultimately be used to design an upgraded LEU core for the UVAR.

23766 (JINR–18-88-759) **On accumulation of transactinides in the IBR-2 reactor.** Lomidze, V.L.; Franklin, Eh. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics. 1988. 10p. (In Russian). Order Number DE90621901. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The calculations of activities of heavy isotopes up to A=242 accumulated in the core of the IBR-2 reactor during its compaign are presented. Sufficient dependence of accumulating of some isotopes activities on operating conditions of the reactor is pointed to. At the same fuel burnup (plutonium-239) two regimes of operation are compared: continuous work of the reactor with 2MW power and work with the same power with periodically repeating pauses (regular operating regime of the IBR-2). Sum duration of pauses per year is 260 days. It is shown that in regime with pauses the accumulated activity of some isotopes is several times (americium) and by the order of magnitude (neptunium, plutonium-236) higher than in the continuous regime. 7 refs.; 1 fig.; 3 tabs.

23767 (ZfK–656) **Results of sample reactivity measurements of structural materials and fission product nuclides in the fast critical assemblies SEG-IV and SEG-V.** Lehmann, E.; Dietze, K.; Faehrmann, K.H.; Huettel, G.; Kumpf, H. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1988. 23p. (In German). Order Number DE90621902. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Applying the Energy-Independent Adjoint Flux Method (EIAF) extensive sample reactivity measurements of structural materials and fission product nuclides have been performed in the fast substitution lattices SEG-IV and -V of the annular zone reactor (RRR) at Rossendorf in the periode from 1982 to 1988. As the contributions of the slowing down to the reactivity value has been essentially suppressed the results of measurements can be used for evaluating the absorption cross-sections of the material under investigation. Furthermore, by measuring reactivity worthes in a extended region of sample size as far as possible one can draw conclusions concerning the resonance data. (author).

2207 Plutonium and Isotope Production Reactors

Refer also to citation(s) 23759, 23760, 23762, 23763, 23764, 23765, 23793, 25211

23768 (ANL/RERTR/TM–9, pp. 370-379) **The Slowpoke-2 reactor with low enrichment uranium oxide fuel.** Atfield, M.D. (AECL Research Co., Chalk River, Ontario (Canada)). Argonne National Lab., IL (USA). May 1988. (CONF-861185–: Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN (USA), 3-6 Nov 1986). In *Reduced enrichment for research and test reactors: Proceedings.* Order Number DE88012713. Available from NTIS, PC A23.

A Slowpoke-2 reactor core contains less than 1 kg of highly enriched uranium (HEU - 93 wt.% U235) and the proliferation risk is very low. However, to overcome proliferation concerns a new low enrichment uranium (LEU - 20 wt.% U235) fueled reactor core was designed. The physics characteristics of this new LEU core ensure the inherent safety of the reactor under all conceivable conditions, and thus the basic Slowpoke safety philosophy, which permits unattended operation, is not affected.

2209 Reactor Safety

Refer also to citation(s) 23541, 23620, 23622, 23726, 23728, 23729, 23740, 23751, 23752, 23756, 23757

23769 (ANL–89/32) **Project plan for the decontamination and decommissioning of the Argonne National Laboratory Experimental Boiling Water Reactor.** Boing, L.E. Argonne National Lab., IL (USA). Dec 1989. 48p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. Order Number DE90007919. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

In 1956, the Experimental Boiling Water Reactor (EBWR) Facility was first operated at Argonne National Laboratory (ANL) as a test reactor to demonstrate the feasibility of operating an integrated power plant using a direct cycle boiling water reactor as a heat source. In 1967, ANL permanently shut down the EBWR and placed it in dry lay-up. This project plan presents the schedule and organization for the decontamination and decommissioning of the EBWR Facility which will allow it to be reused by other ANL scientific research programs. The project total estimated cost is $14.3M and is projected to generate 22,000 cubic feet of low-level radioactive waste which will be disposed of at an approved DOE burial ground. 18 figs., 3 tabs.

23770 (BNL–43843) **Tensile testing and scanning electron microscope examination of Charpy impact specimens from the HFBR.** Czajkowski, C.J.; Schuster, M.H.; Roberts, T.C. Brookhaven National Lab., Upton, NY (USA). Jan 1990. 20p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC02-76CH00016. Order Number DE90008512. Available from NTIS, PC A03/MF A01; OSTI; INIS.

The Materials Technology Group of the Department of Nuclear Energy (DNE) at Brookhaven National Laboratory (BNL) has performed a fractographic examination of neutron irradiated and unirradiated Charpy "V" notch specimens which have been deformed to failure in a tensile testing apparatus. The evaluation was carried out using a scanning electron microscope (SEM) to evaluate the fracture mode. Photomicrographs were then evaluated to determine if ductile areas were present on the fracture surfaces of the specimens. The irradiated tensile tests (Charpy "V" notch configuration) showed minimum notch tensile strengths of 37.2 Ksi before failure. The unirradiated 6061 T-6 material exhibited a minimum notch tensile strength of 41.9 Ksi. 2 refs., 21 figs., 1 tab.

23771 (BNL–43929) **Interface-flux nodal transport method.** Kohut, P. Brookhaven National Lab., Upton, NY (USA). [1990]. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-9004138–3: 3. Canadian Nuclear Society international conference on simulation methods in nuclear engineering, Montreal (Canada), 18-20 Apr 1990). Order Number DE90008515. Available from NTIS, PC A01/MF A01; OSTI; INIS; GPO Dep.

The development of the interface-flux nodal (IFN) method is presented to determine the flux distribution in reactor cells, cores and shielding. The method offers geometric flexibility, high order of spatial expansions of the node-interior sources and the node surface quantities. The surface-integral formulation is reduced to response-matrix-like global equations through coupling coefficients which are generalized expressions for escape and transmission probabilities. The spatial distribution of the neutron flux may be represented by high order polynomials using geometric basis functions determined by a least-square minimalization technique. The angular dependency of the outgoing/incoming surface flux components is treated using a general DP_n expansion and the spatial variation is handled with a boundary element technique. The scattering iterations are eliminated by using an explicit expansion of the scalar fluxes. Based on the IFN method a computer code has been developed capable of calculating fixed-source and eigenvalue problems. Test problems for 1-D and 2-d X-Y and hexagonal geometries are presented including comparison with other techniques to demonstrate the validity and accuracy of the IFN method. 15 refs., 3 figs., 5 tabs.

23772 (BNL-NUREG–43152) **Relay testing at Brookhaven National Laboratory.** Bandyopadhyay, K.; Hofmayer, C. Brookhaven National Lab., Upton, NY (USA). [1989]. 15p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (CONF-8910222–19: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). Order Number DE90008517. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Brookhaven National Laboratory (BNL) is conducting a seismic test program on relays. The purpose of the test program is to investigate the influence of various designs, electrical and vibration parameters on the seismic capacity levels. The first series of testing has been completed and performed at Wyle Laboratories. The major part of the test program consisted of single axis, single frequency sine dwell tests. Random multiaxis, multifrequency tests were also performed. Highlights of the test results as well as a description of the testing methods are presented in this paper. 10 figs.

23773 (BNL-NUREG–43173) **The High Level Vibration Test Program.** Hofmayer, C.H. (Brookhaven National Lab., Upton, NY (USA)); Curreri, J.R.; Park, Y.J.; Kato, W.Y.; Kawakami, S. Brookhaven National Lab., Upton, NY (USA). [1989]. 18p. Sponsored by Electric Power Research Institute; Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (CONF-8910222–18: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). Order Number DE90008516. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

As part of cooperative agreements between the United States and Japan, tests have been performed on the seismic vibration table at the Tadotsu Engineering Laboratory of Nuclear Power Engineering Test Center (NUPEC) in Japan. The objective of the test program was to use the NUPEC vibration table to drive large diameter nuclear power piping to substantial plastic strain with an earthquake excitation and to compare the results with state-of-the-art analysis of the problem. The test model was designed by modifying the 1/2.5 scale model of the PWR primary coolant loop. Elastic and inelastic seismic response behavior of the test model was measured in a number of test runs with an increasing excitation input level up to the limit of the vibration table. In the maximum input condition, large dynamic plastic strains were obtained in the piping. Crack initiation was detected following the second maximum excitation run. The test model was subjected to a maximum acceleration well beyond what nuclear power plants are designed to withstand. This paper describes the overall plan, input motion development, test procedure, test results and comparisons with pre-test analysis. 4 refs., 16 figs., 2 tabs.

23774 (BNL-NUREG–43960) **Responding to emergencies: How organization and management make a difference.** Metlay, D.S.; Haber, S.B.; Luckas, W.J. Brookhaven National Lab., Upton, NY (USA). [1989]. 5p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (CONF-8910222–17: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). Order Number DE90008514. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

There is an observable and definable process that occurs during the course of responding to an abnormal event at a nuclear power plant. Each of the elements that comprise that process involves collective action and consequently is influenced by the character and effectiveness of organizational and managerial arrangements. Factors which affect each element include overt ones like the allocation of authority and responsibility and the skill of personnel, as well as covert factors like the methods used to resolve uncertainty. The purpose of this research project is to examine the process of response that occurs to an abnormal event at a nuclear power plant and where possible to identify the organizational and management factors that influence that process.

23775 (CEA-DAS–578) **TMI-2 core materials examination at CEA.** Duco, J. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (FR). Dept. d'Analyses de Surete); Trotabas, M.; Geoffroy, G.; Robin, M.; Le Marois, G. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete. Mar 1989. 34p. (CONF-881024–: ANS topical meeting on the TMI-2 accident: materials behavior and plant recovery technology, Washington, DC (USA), 30 Oct - 4 nov 1988). Order Number DE90762041. Available from NTIS (US Sales Only), PC A03/MF A01.

In the framework of the OECD/CSNI Task Group on Three Mile Island 2, CEA examined five samples retrieved from the reactor damaged core: a slightly damaged fuel rod chunk from assembly

L1 of the core external row, a rod remnant in position C7 hanging from the assembly head and three core bore rocks including a rock cut - G12-P1 (section D), K9-P3-M and O7-P5 - from both the ceramic and agglomerate regions of the damaged core. The scheduled analyses included visual observation, immersion density, metallography, microprobe analysis (WDX), X-ray diffraction, thermogravimetry, gamma spectroscopy and neutron activation analysis. The information gained from these examinations provided some assessments of the maximum temperatures reached locally during the accident, an insight into a possible fuel degradation mechanism for the rod in position C7, and indications about fission product and control or structure material behavior. Such data, involving a small number of samples, will be grouped with those from the other contributing laboratories in order to obtain an extensive data base and try to arrive at a consensus on the comprehension of the TMI-2 accident and, presumably, on the lessons to be learned in order to avoid the recurrence of a core melt.

23776 (CONF-900382–1) **Research and development associated with licensing of MHTGR [Modular High Temperature Gas-Cooled Reactor].** Jones, H. Oak Ridge National Lab., TN (USA). [1990]. 51p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. From 1. symposium on high-temperature gas-cooled reactor (HTGR) technologies design, licensing requirements and supporting technologies; Tokyo (Japan); 19-20 Mar 1990. Order Number DE90008553. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

The Modular High Temperature Gas-Cooled Reactor (MHTGR) currently under development by the US Department of Energy (US-DOE) for commercial applications has top-level goals of producing safe, economical power for the US utility industry. The utility industry has been represented in formulating design and licensing requirements through both a "Utility User Requirements Document" and by participating in the DOE system engineering process known as the "Integrated Approach." The result of this collaboration has been to set stringent goals for both the safety and operational reliability of the MHTGR. To achieve these goals, the designer must have access to a more comprehensive data base of properties in several fields of technology than is currently available. A technology development program has been planned to provide this data to the designer in time to support both his design activities and the submittal of formal licensing application documents. The US-DOE has chosen the Oak Ridge National Laboratory (ORNL) to take the lead in planning and executing these technology programs. When completed these will augment the designer's current data base and provide the necessary depth to meet the stringent goals which have been set for the MHTGR. It is worth noting that the goals of safety and operational reliability are complementary, and the data required from the technology development program will be similar. Therefore, the program to support the licensing of the MHTGR is not separate from that required for design, but is a subset of that which meets all the requirements that result from implementing the US-DOE's integrated approach. 38 figs.

23777 (CONF-9002100–1) **Upgrade of materials irradiation facilities in HFIR [High Flux Isotope Reactor].** Thoms, K.R.; Montgomery, B.H.; West, C.D. Oak Ridge National Lab., TN (USA). [1990]. 31p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From International group on research reactors conference; Knoxville, TN (USA); 28 Feb - 2 mar 1990. Order Number DE90008744. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Modifications have been made to the High Flux Isotope Reactor (HFIR) which permit the operation of instrumented irradiation capsules in the target region, and more and larger capsules in the removable beryllium region. As many as two instrumented target capsules can now be accommodated and positions for up to eight 46-mm-diam instrumented capsules are now available in the removable beryllium region. One instrumented target capsule has already been irradiated and new capsules have been prepared for irradiation in the removable beryllium region.

23778 (CONF-9005135–2) **Fuzzy logic controller to a steam generator feedwater flow.** Raju, G.V.S. (Ohio Univ., Athens, OH (USA). Dept. of Electrical and Computer Engineering); Zhou, Jun; Kisner, R.A. Oak Ridge National Lab., TN (USA). [1990]. 2p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. From 1990 American control conference; San Diego, CA (USA); 23-25 May 1990. Order Number DE90008896. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Since the pioneering works of Zadeh and Mamdani and Assilian the conventional fuzzy logic controller has been successfully implemented in many industrial applications As the number of system variables increase, the number of rules in a conventional complete rule set increases exponentially The concept of hierarchical rule set is proposed here such that the number of rules constituting the fuzzy controller will increase linearly (not exponentially) with the number of system variables The purpose of this paper is two fold: (1) to summarize some of the recent and relevant results of the hierarchical rule set and (2) to describe the application of this hierarchical structure for the design of a fuzzy logic controller to a steam generator feedwater flow. 5 refs., 2 figs.

23779 (EGG-M–89191) **Age-dependent risk quantification using standard maintenance records.** Roesener, W.S.; Wolford, A.J.; Atwood, C.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 23p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC07-76ID01570. (CONF-8910363–1: Society for Risk Analysis annual meeting, San Francisco, CA (USA), 29 Oct - 1 nov 1989). Order Number DE90007021. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The risk associated with the operation of many individual nuclear power plants has been calculated using Probabilistic Risk Assessment (PRA) techniques. To date, PRA calculations have used time-averaged unreliabilities and unavailabilities as inputs such that the calculated risks are a time-average and say nothing of the risk trends. The calculation of an age-dependent risk is a fairly simple matter given the age-dependent inputs. The development of valid age-dependents inputs is not such a simple matter. It involves the reduction of large masses of information, which were not recorded for the purposes of PRA, into failure time-histories, and the representation of these time-histories by a model. The results must then be tested to check certain assumptions that are made when the model is applied to the data. The specific methodology developed for the reduction of the information and the application and testing of the model is outlined in a stepwise fashion in this paper. Results of the application of the methodology to the Maintenance Records from the Auxiliary Feedwater (AFW) System of an older Pressurized Water Reactor (PWR) are used throughout the paper to demonstrate the methodology. In addition, a very brief discussion of the AFW system is presented to allow better understanding of the application. 6 refs., 7 figs., 4 tabs.

23780 (EPRI-NP–6676) **Utility industry evaluation of the Modular High-Temperature Gas-Cooled Reactor: Final report.** Burstein, S. (Wisconsin Electric Power Co., Milwaukee, WI (USA)); Bitel, J.S.; Tramm, T.R.; High, M.D.; Neils, G.H.; Tomonto, J.R.; Weinberg, C.J. Electric Power Research Inst., Palo Alto, CA (USA); Wisconsin Electric Power Co., Milwaukee, WI (USA); Commonwealth Edison Co., Chicago, IL (USA); Tennessee Valley Authority, Knoxville, TN (USA); Northern States Power Co., Minneapolis, MN (USA); Florida Power and Light Co., Miami, FL (USA); Pacific Gas and Electric Co., San Francisco, CA (USA). c Feb 1990. 98p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A team of utility industry representatives evaluated the Modular High Temperature Gas-Cooled Reactor plant design, a current design created by an industrial team led by General Atomics under Department of Energy sponsorship and with support provided by utilities through Gas-Cooled Reactor Associates. The utility industry team concluded that the plant design should be considered a viable application of an advanced nuclear concept and deserves continuing development. Specific comments and recommendations are provided as a contribution toward improving a very promising plant design. 2 refs.

23781 (FRNC-TH–3470) **Some considerations about the effects of population irradiation after the Chernobyl accident.** Hauser, P. Nancy-1 Univ., 54 (France). 1987. 106p. (In French). Order Number DE90762016. Available from NTIS (US Sales Only), PC A06/MF A01.

This thesis carried out with the help of CEA documents and statistical, historical and experimental studies intended to answer to some questions raised by the Chernobyl accident, concerning: risks induced by the reactor explosion in USSR and the neighbouring countries; possibility of similar catastrophe in France and countermeasures used by the authorities.

23782 (IWGFPT–27) **Water reactor fuel behaviour and fission products release in off-normal and accident conditions: Proceedings of a technical committee meeting held in Vienna, 10-13 November 1986.** International Atomic Energy Agency, Vienna (Austria). International Working Group on Water Reactor Fuel Performance and Technology. Sep 1987. 259p. (CONF-8611109–: IAEA technical committee meeting on water reactor fuel behaviour and fission products release in off-normal and accident conditions, Vienna (Austria), 10-13 Nov 1986). Order Number DE90621928. Available from NTIS (US Sales Only), PC A12/MF A01; OSTI; INIS.

The present meeting was scheduled by the International Atomic Energy Agency upon the proposal of the Members of the International Working Group on Water Reactor Fuel Performance and Technology and held at the IAEA Headquarters in Vienna from 10 to 13 November 1986. Thirty participants from 17 countries and an international organization attended the meeting. Eighteen papers were presented from 13 countries and one international organization. The meeting was composed of four sessions and covered subjects related to: physico-chemical properties of core materials under off-normal conditions, and their interactions up to and after melt-down (5 papers); core materials deformation, relocation and core coolability under (severe) accident conditions (4 papers); fission products release: including experience, mechanisms and modelling (5 papers); power plant experience (4 papers). A separate abstract was prepared for each of these 18 papers. Four working groups covering the above-mentioned topics were held to discuss the present status of the knowledge and to develop recommendations for future activities in this field. Refs, figs and tabs.

23783 (NUREG–0896-Suppl.9) **Safety Evaluation Report related to the operation of Seabrook Station, Units 1 and 2 (Docket Nos. 50-443 and 50-444): Supplement No. 9.** Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation. Mar 1990. 164p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A08/MF A01 - GPO; OSTI; INIS.

This report is Supplement No. 9 to the Safety Evaluation Report (SER) (NUREG-0896, March 1983) for the application filed by the Public Service Company of New Hampshire, et al., for licenses to operate Seabrook Station, Units 1 and 2. It has been prepared by the Office of Nuclear Reactor Regulation of the US Nuclear Regulatory Commission and provides recent information on open items identified in the SER. The facility is located in Seabrook, New Hampshire. Subject to favorable resolution of the items discussed in this report, the staff concludes that the facility can be operated by the applicant without endangering the health and safety of the public. 70 refs., 1 fig., 1 tab.

23784 (NUREG/CP–0109) **Leak-Before-Break: Further developments in regulatory policies and supporting research: Proceedings.** Wilkowski, G.M. (Battelle, Columbus, OH (USA)); Chao, K.-S. (eds.). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Battelle, Columbus, OH (USA). Feb 1990. 350p. Sponsored by Nuclear Regulatory Commission. (CONF-8905290–: Seminar on leak-before-break: further developments in regulatory policies and supporting research, Taipei (Taiwan), 11-12 May 1989). Available from NTIS, PC A15/MF A01 - GPO; OSTI; INIS.

The fourth in a series of international Leak-Before-Break (LBB) Seminars supported in part by the US Nuclear Regulatory Commission was held at the National Central Library in Taipei, Taiwan on May 11 and 12, 1989. The seminar updated the international polices and supporting research on LBB. Attendees included representatives from regulatory agencies, electric utilities, nuclear power plant fabricators, research organizations, and academic institutions. Regulatory policy was the subject of presentations by Mr. G. Arlotto (US NRC, USA) Dr. B. Jarman (AECB, Canada), Dr.P. Milella (ENEA-DISP, Italy), Dr. C. Faidy (EDF/Septen, France), and Dr. K. Takumi (NUPEC, Japan). A paper by Mr. K. Wichman and Mr. A. Lee of the US NRC Office of Nuclear Reactor Regulation is included as background material to these proceedings; it discusses the history and status of LBB applications in US nuclear power plants. In addition, several papers on the supporting research programs described regulatory policy or industry standards for flaw evaluations, e.g., the ASME Section XI code procedures. Supporting research programs were reviewed on the first and second day by several participants from Taiwan, US, Japan, Canada, Italy, and France. Each individual paper has been cataloged separately.

23785 (NUREG/CP–0110) **International workshop on new developments in occupational dose control and ALARA implementation at nuclear power plants and similar facilities: Proceedings.** Baum, J.W. (Brookhaven National Lab., Upton, NY (USA)); Dionne, B.J.; Kahn, T.A. (comps.). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Feb 1990. 578p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (BNL-NUREG–52226;CONF-890935–: International workshop on new developments in occupational dose control and ALARA implementation at nuclear power plants and similar facilities, Upton, NY (USA), 18-21 Sep 1989). Available from NTIS, PC A23/MF A01 - GPO; OSTI; INIS.

This report contains summaries of papers and discussions presented at the International Workshop on New Developments in Occupational Dose Control and ALARA Implementation at Nuclear Power Plants and Similar Facilities held at Brookhaven National Laboratory, Upton, New York, September 18–21, 1989. The purpose of this workshop was to bring together scientists, engineers, regulators, and administrators who are involved with occupational dose control at nuclear facilities to exchange information on recent developments from their countries. The eleven countries represented included: Canada, Finland, France, Germany, Italy, Japan, Luxembourg, Sweden, Switzerland, United Kingdom, and the United States of America. The workshop was organized into seven sessions with 20-minute papers and four sessions with 5-minute discussions. The topics for the paper sessions included: Session 1, ALARA status, studies, and organization; Session 3, ALARA engineering in design and modifications; Session 5, system chemistry and water purification; Session 7, ALARA in operation I; Session 9, ALARA in operation II; Session 10, ALARA in operation III; and Session 11, the NEA Information System on Occupational Exposure. This workshop was sponsored jointly by the US Nuclear Regulatory Commission and the US Department of Energy, in cooperation with the Organization for Economic Cooperation and Development, Nuclear Energy Agency. Each individual paper has been catalogued separately.

23786 (NUREG/CR–4668) **Damaged Fuel Experiment DF-1: Results and analyses.** Gasser, R.D.; Fryer, C.P.; Gauntt, R.O.; Marshall, A.C.; Reil, K.O.; Stalker, K.T. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; Sandia National Labs., Albuquerque, NM (USA). Jan 1990. 261p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (SAND–86-1030). Available from NTIS, PC E10/MF E01; OSTI; INIS.

Includes 2 microfiche supplements.

A series of in-pile experiments addressing LWR severe fuel damage phenomena has been conducted in the Annular Core Research Reactor (ACRR) at Sandia National Laboratories. The ACRR Debris Formation and Relocation (DF) experiments are quasi-separate effects tests that provide a data base for the development and verification of models for LWR severe core damage accidents. The first experiment in this series, DF-1, was performed on March 15, 1984, and the results are presented in this report. The DF-1 experiment examined the effects of low initial clad oxidation conditions on fuel damage and relocation processes. The DF-1 test assembly consisted of a nine-rod square-matrix bundle that employed PWR-type fuel rods with a 0.5-m fissile length. The fuel rods were composed of 10% enriched UO_2 pellets within a zircaloy-4 cladding. Steam flowed through the test bundle at flow rates varying between 0.5 and 3 g/s, and the ACRR maintained a peak power level of 1.5 MW during the high temperature oxidation phase of the test inducing ~8.5 kW fission power and ~20 kW peak oxidation power in the assembly. Visual observation showed early clad relocation and partial blockage formation at the grid spacer location accompanied

by production of a dense aerosol. Posttest cross sections show liquefaction losses of fuel in excess of 10 volume percent, as well as large fractional losses of cladding material from the upper two-thirds of the bundle. The quantity of hydrogen measured during the test was consistent with the observed magnitude of cladding oxidation. Oxidation driven heating rates of 25 K/s and peak temperatures in excess of 2525 K were observed. The analyses, interpretation, and application of these results to severe fuel damage accidents are discussed. 27 refs., 118 figs., 23 tabs.

23787 (NUREG/CR–4691-Vol.2) **MELCOR Accident Consequence Code System (MACCS): Model description.** Jow, H.N. (Sandia National Labs., Albuquerque, NM (USA)); Sprung, J.L.; Ritchie, L.T.; Rollstin, J.A.; Chanin, D.I. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; Sandia National Labs., Albuquerque, NM (USA). Feb 1990. 176p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (SAND–86-1562-Vol.2). Available from NTIS, PC A09/MF A01 - GPO; OSTI; INIS.

This report describes the MACCS computer code. The purpose of this code is to simulate the impact of severe accidents at nuclear power plants on the surrounding environment. MACCS has been developed for the US Nuclear Regulatory Commission to replace the previously used CRAC2 code, and it incorporates many improvements in modeling flexibility in comparison to CRAC2. The principal phenomena considered in MACCS are atmospheric transport, mitigative actions based on dose projection, dose accumulation by a number of pathways including food and water ingestion, early and latent health effects, and economic costs. The MACCS code can be used for a variety of applications. These include (1) probabilistic risk assessment (PRA) of nuclear power plants and other nuclear facilities, (2) sensitivity studies to gain a better understanding of the parameters important to PRA, and (3) cost-benefit analysis. This report is composed of three volumes. Volume I, the User's Guide, describes the input data requirements of the MACCS code and provides directions for its use as illustrated by three sample problems. Volume II, the Model Description, describes the underlying models that are implemented in the code, and Volume III, the Programmer's Reference Manual, describes the code's structure and database management. 59 refs., 14 figs., 15 tabs.

23788 (NUREG/CR–4691-Vol.3) **MELCOR Accident Consequence Code System (MACCS): Programmer's Reference Manual.** Rollstin, J.A. (GRAM, Inc., Albuquerque, NM (USA)); Chanin, D.I.; Jow, H.N. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; Sandia National Labs., Albuquerque, NM (USA). Feb 1990. 317p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (SAND–86-1562-Vol.3). Available from NTIS, PC A14/MF A01 - GPO; OSTI; INIS.

This report describes the MACCS computer code. The purpose of this code is to simulate the impact of severe accidents at nuclear power plants on the surrounding environment. MACCS has been developed for the US Nuclear Regulatory Commission to replace the previously used CRAC2 code, and it incorporates many improvements in modeling flexibility in comparison to CRAC2. The principal phenomena considered in MACCS are atmospheric transport, mitigative actions based on dose projections, dose accumulation by a number of pathways including food and water ingestion, early and latent health effects, and economic costs. The MACCS code can be used for a variety of applications. These include (1) probabilistic risk assessment (PRA) of nuclear power plants and other nuclear facilities, (2) sensitivity studies to gain a better understanding of the parameters important to PRA, and (3) cost-benefit analysis. This report is composed of three volumes. Volume I, the User's Guide, describes the input data requirements of the MACCS code and provides directions for its use as illustrated by three sample problems. Volume II, the Model Description, describes the underlying models that are implemented in the code, and Volume III, the Programmer's Reference Manual, describes the code's structure and database management.

23789 (NUREG/CR–5289) **Closeout of IE Bulletin 79-23: Potential failure of emergency diesel generator field exciter transformer.** Foley, W.J. (Parameter, Inc., Elm Grove, WI (USA)); Dean, R.S.; Hennick, A. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Operational Events Assessment; Parameter, Inc., Elm Grove, WI (USA). Mar 1990. 29p. Sponsored by Nuclear Regulatory Commission. (PARAMETER/IE–180). Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

Documentation is provided in this report for the closeout of IE Bulletin 79-23 regarding the potential failure of emergency diesel generator field exciter transformers. Closeout is based upon the implementation and verification of three actions required by the bulletin. Evaluation of utility responses and NRC/Region inspection reports indicates that the bulletin is closed for all of the 119 nuclear power facilities with an operating license or a construction permit at the time the bulletin was issued, September 12, 1979. Deviations from bulletin testing requirements, along with licensee justifications, are listed. It is concluded that the problem of concern was not generic, since only two plants, Nine Mile Point 1 and Turkey Point, required modifications to correct connections which could cause high circulating currents. The problem at Turkey Point is described in the bulletin (see page A-1). Background information is supplied in the Introduction and Appendix A.

23790 (NUREG/CR–5404-Vol.1) **Auxiliary feedwater system aging study: Volume 1.** Casada, D.A. (Oak Ridge National Lab., TN (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Oak Ridge National Lab., TN (USA). Mar 1990. 171p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. (ORNL–6566/V1). Available from NTIS, PC A09/MF A01 - GPO; OSTI; INIS.

This report documents the results of a study of the Auxiliary Feedwater (AFW) System that has been conducted for the US Nuclear Regulatory Commission's Nuclear Plant Aging Research Program. The study reviews historical failure data available from the Nuclear Plant Reliability Data System, Licensee Event Report Sequence Coding and Search System, and Nuclear Power Experience data bases. The failure histories of AFW System components are considered from the perspectives of how the failures were detected and the significance of the failure. Results of a detailed review of operating and monitoring practices at a plant owned by a cooperating utility are presented. General system configurations and pertinent data are provided for Westinghouse and Babcock and Wilcox units. 33 figs., 53 tabs.

23791 (NUREG/CR–5527) **Risk sensitivity to human error in the LaSalle PRA [probabilistic risk assessment].** Wong, S. (Brookhaven National Lab., Upton, NY (USA)); Higgins, J.; O'Hara, J.; Crouch, D.; Luckas, W. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Radiation Protection and Emergency Preparedness; Brookhaven National Lab., Upton, NY (USA). Mar 1990. 150p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (BNL-NUREG–52228). Available from NTIS, PC A07/MF A01 - GPO; OSTI; INIS.

A sensitivity evaluation was conducted to assess the impact of human errors on the internal event risk parameters in the LaSalle plant. The results provide the variation in the risk parameters, namely, core melt frequency and accident sequence frequencies, due to hypothetical changes in human error probabilities. Also provided are insights derived from the results, which highlight important areas for concentration of risk limitation efforts associated with human performance. 14 refs., 28 figs., 9 tabs.

23792 (NUS–5125) **Radiological risk analysis of potential SP-100 space mission scenarios.** Bartram, B.W.; Weitzberg, A. NUS Corp., Gaithersburg, MD (USA). 19 Aug 1988. 81p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC01-88NE32135. Order Number DE90008297. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This report presents a radiological risk analysis of three representative space mission scenarios utilizing a fission reactor. The mission profiles considered are: a high-altitude mission, launched by a TITAN IV launch vehicle, boosted by chemical upper stages into its operational orbit, a interplanetary nuclear electric propulsion (NEP) mission, started directly from a shuttle parking orbit, a low-altitude mission, launched by the Shuttle and boosted by a chemical stage to its operational orbit, with subsequent disposal boost after operation. 21 refs., 12 figs., 7 tabs.

23793 (PNL-SA-17794) **Alternatives for decommissioning the surplus production reactors at Hanford.** Moore, E.B. Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. (CONF-900210-33: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90008618. Available from NTIS, PC A02/MF A01 - OSTI.

Alternatives for decommissioning eight surplus plutonium production reactors owned by the US Department of Energy (DOE) at the DOE's Hanford Site were analyzed in a draft environmental impact statement published by DOE in March 1989. The alternatives include no action, immediate one-piece removal, safe storage followed by deferred one-piece removal, safe storage followed by deferred dismantlement, and in situ decommissioning. The environmental impacts of decommissioning by any alternative are not great, the most significant impact being worker exposure to radioactivity. This impact (for all eight reactors) is approximately equal to the annual worker dose at a large commercial nuclear power plant. Uncertainty as to the applicability to decommissioning of the Resource Conservation and Recovery Act and/or the Comprehensive Environmental Response, Liability, and Compensation Act may become an issue in the implementation of decommissioning. 1 ref., 1 tab.

23794 (WHC-SA-0865) **Whole core neutronics modeling of a TRIGA reactor using integral transport theory.** Schwinkendorf, K.N.; Toffer, H. Westinghouse Hanford Co., Richland, WA (USA). Mar 1990. 8p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930. (CONF-9003102-1: 12. U.S. TRIGA users conference, Austin, TX (USA), 11-14 Mar 1990). Order Number DE90008479. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An innovative analysis approach for performing whole core reactor physics calculations for TRIGA reactors has been employed recently at the Westinghouse Hanford Company. A deterministic transport theory model with sufficient geometric complexity to evaluate asymmetric loading patterns was used. Calculations of this complexity have been performed in the past using Monte Carlo simulation, such as the MCNP code. However, the Monte Carlo calculations are more difficult to prepare and require more computer time. On the Hanford Site CRAY XMP-18 computer, the new methods required less than one-third of the central processing unit time per calculation as compared to an MCNP calculation using 100,000 neutron histories. 4 refs., 4 figs., 2 tabs.

24 POWER TRANSMISSION AND DISTRIBUTION

2401 Power Systems

Refer also to citation(s) 23843

2402 Power System Networks, Transmission and Distribution

Refer also to citation(s) 23844, 25211

23795 (AD-A-215444/1/XAB) **25-kVA amorphous metal-core transformer developmental test report. Final report, FY87-88.** Urata, G.V.; Franchi, J.O. Naval Civil Engineering Lab., Port Hueneme, CA (USA). Aug 1989. 204p. (NCEL-TN-1801). Available from NTIS, PC A10/MF A02.

Availability: Document partially illegible.

Naval Civil Engineering Laboratory (NCEL) has completed a test and evaluation program for 25-kVA amorphous metal-core transformers. These transformers save energy by reducing no-load losses by 60 to 70%. No-load losses are estimated to cost the Navy millions annually and if all of the Navy transformers were replaced by amorphous metal-core transformers, the Navy would save millions a year. The program objective was to evaluate the electrical performance and operational reliability of the amorphous metal-core transformers compared to conventional silicon-steel transformers.

23796 (LA-UR-90-510-Rev.) **An analysis of the reliability of the Los Alamos National Laboratory electrical system.** Bott, T.F. Los Alamos National Lab., NM (USA). [1990]. 13p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-9004137-1: 11. advances in reliability technology symposium, Liverpool (UK), 18-20 Apr 1990). Order Number DE90007538. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper discusses the results of a study of the reliability of the Los Alamos National Laboratory electrical system and an assessment of the risk arising from power interruptions and outages. Our study was intended to provide a current status of the system and to rank upgrades to improve the system. In this study, we used fault-tree analysis, cause-consequence analysis, and directed graphs. The study resulted in a ranking of the relative importance of the consequences of power loss to various Los Alamos technical sites and facilities, sets of equipment whose failure will lead to loss of power to the sites, and statistical estimates of the frequency of power loss to sites and facilities. 1 tab.

23797 (PNL-SA-17339) **Estimating methodology for a large regional application of conservation voltage reduction.** De Steese, J.B. (Pacific Northwest Lab., Richland, WA (USA)); Merrick, S.B.; Kennedy, B.W. Pacific Northwest Lab., Richland, WA (USA). Feb 1990. 19p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC06-76RL01830. (CONF-900202-6: IEEE Power Engineering Society winter meeting, Atlanta, GA (USA), 4-9 Feb 1990). Order Number DE90008616. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Conservation Voltage Reduction (CVR) is an established and cost- effective practice that has motivated many utilities to investigate its application on individual systems. This paper describes a supply-curve methodology that can determine the conservation value of CVR applied to many distribution systems in a region. In the area served by Bonneville Power Administration involving approximately 150 utilities, the systematic implementation of CVR could conserve between 170 and 268 Average Megawatts at a cost of 5¢/kWh. This was shown to be a larger resource than might be achievable by applying more conventional efficiency improvements to transmission and distribution systems in the region. 11 refs., 3 figs., 5 tabs.

2407 Economic, Industrial, and Business Aspects

Refer also to citation(s) 23841, 23842, 23844

23798 (DOE/EIA-0226(89/12)) **Electric power monthly, December 1989.** USDOE Energy Information Administration, Washington, DC (USA). Office of Coal, Nuclear, Electric and Alternate Fuels. 13 Mar 1990. 178p. Sponsored by U.S. DOE Energy Information Administration. Order Number DE90008584. Available from NTIS, PC A08/MF A01 - GPO - OSTI; GPO Dep.

The Electric Power Monthly (EPM) is prepared by the Electric Power Division; Office of Coal, Nuclear, Electric and Alternate Fuels; Energy Information Administration (EIA); Department of Energy. The purpose of this publication is to provide energy decision makers with accurate and timely information. The EPM presents monthly summaries of electric utility statistics at the national, Census division, and state level for net generation, fuel consumption, fuel stocks, quantity and quality of fuel, cost of fuel, electricity sales, and average retail prices of electricity. Data on net generation are also displayed at the North American Electric Reliability Council (NERC) region level. Additionally, company and plant level information are published in the EPM on capability of new plants, net generation, fuel consumption, fuel stocks, quantity and quality of fuel, and cost of fuel. Quantity, quality, and cost of fuel data lag the net generation, fuel consumption, fuel stocks, electricity sales, and retail prices data by 1 month. This difference in reporting appears in the national, Census division, and state level tables. However, at the plant level, all statistics presented are for the earlier month for the purpose of comparison. More information can be obtained by writing or calling the National Energy Information Center, EI-231, Forrestal Building, Washington, DC 20585, (202)586-8800. The data in this report are presented for a wide audience including Congress, federal and state agencies, the electric utility industry,

and the general public. The EIA collected the information in this report to fulfill its data collection and dissemination responsibilities as specified in the Federal Energy Administration Act of 1974 (Public Law 93-275) as amended. 10 refs., 1 fig., 40 tabs.

25 ENERGY STORAGE

2506 Thermal

Refer also to citation(s) 23887

23799 (TNO-TPD–713.020) **Causes of and measures to prevent high heat losses in aquifers.** Wijsman, A.J.T.M. Nijverheidsorganisatie TNO, Delft (Netherlands). Technisch Physische Dienst. Oct 1988. 124p. (In Dutch). Order Number DE90752704. Available from NTIS (US Sales Only), PC A06/MF A01.

The title subject concerns aquifers in Groningen, Netherlands. The higher heat losses of the heat storage system are mainly caused by: the fact that the top insulation has been calculated with a lower K-value; a higher minimal temperature of use with regard to the heat losses to the surrounding ground; ground water flow by natural convection and by percolating currents with regard to heat losses to the surrounding ground. The observed extra heat losses of about 145 MWh appear to be caused equally by the above-mentioned causes. The three appendices are the report sections with calculated and measured results. The titles are respectively: 'Heat loss of ground heat storage in Groningen. Comparison of measured and calculated heat loss' for appendix A; 'Heat loss in aquifers and sensitivity analysis' for appendix B; and 'Hydrologic and hydrochemical observations' for appendix C. 1 fig., 3 apps.

2509 Batteries

23800 (LBL–27964) **All-solid-state thin-film rechargeable lithium batteries using solid redox polymerization electrodes.** Liu, M.; Visco, S.J.; DeJonghe, L.C. Lawrence Berkeley Lab., CA (USA). Oct 1989. 8p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. (CONF-8910107–11: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989). Order Number DE90008665. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Lithium batteries using solid redox polymerization electrodes maintain the advantages of all-solid-state thin-film systems while overcoming the limitations of using intercalation compounds as cathodes (i.e., insufficient rate capability and unsatisfactory cathode utilization). Laboratory Li/PEO/SRPE cells have already demonstrated much higher power capability, energy density, and cathode utilization than analogous Li/PEO/TiS_2 cells. One of the Li/PEO/SRPE cells has achieved 350 cycles from 50°C to 93°C with a sustained energy density of 264 Wh/kg (241 Wh/1), power density of 160 W/kg (144 W/1), and 38% to 75% of cathode utilization at 90% voltage efficiency. At 100°C, power densities of over 2400 W/kg and energy density of 200 W/kg have been achieved with up to 96% utilization of cathode capacity. At ambient temperatures, the cells can be discharged at a current density of 250 $\mu A/cm^2$, achieving a film capacity of 0.5 coulombs/cm^2. 7 refs., 5 figs.

23801 (LBL–28083) **Novel electrodes for advanced energy storage systems.** Liu, M. Lawrence Berkeley Lab., CA (USA). Sep 1989. 163p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. Order Number DE90008667. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The objective of this research has been to explore advanced cathode materials and the corresponding energy storage systems based on these materials. A diverse group of organodisulfides (RSSR) and solid redox polymerization electrodes (SRPE) have been developed in this laboratory. The attractive features of these materials include low operating temperatures (ambient to 150°C), high energy densities, low cost, passive behavior to many materials, and low toxicity (biodegradable). Furthermore, their properties can easily be tailored for various applications by appropriate selection of the organic groups, while their reversibility with respect to many metals allows for a great choice of negative electrodes. The discovery of redox polymerization electrodes may revolutionize energy storage systems. This thesis summarizes a number of publications regarding electrochemical properties of these materials and the performance of the cells based on them. Detailed descriptions of impedance spectroscopy studies, 4-probe polarization measurements, and ambient temperature lithium batteries based on redox polymerization electrodes are not covered in the thesis and will be addressed in subsequent communications.

29 ENERGY PLANNING AND POLICY

2901 Energy Analysis and Modeling

Refer also to citation(s) 23879

23802 (NEI-DK–264) **Proceedings of the conference on the systems analysis approach to environmental and natural resources management in the Baltic region.** Vidal, R.V.; Straszak, A.; Ravn, H. (eds.). Technical Univ. of Denmark, Lyngby (Denmark). Inst. of Mathematical and Operations Research. 1989. 268p. (CONF-8809459–: Conference on the systems analysis approach to environmental and natural resources management in the Baltic region, Gdansk (Poland), 26-29 Sep 1988). Order Number DE90760200. Available from NTIS (US Sales Only), PC A12/MF A01.

The Conference was organized jointly by the Polish and the Danish Operational Research Societies. Sixty-one researchers covering both Natural and Systems Sciences met at the Conference and Training Center in Sobieszewo. There were participants from all the countries of the Baltic Region. U.S.A., Italy and Canada were also represented. The chief aim of the Conference was to provide a forum for the presentation and discussion of recent advances in analysis and solving of environmental and natural resources management problems and solving of environmental and natural resources management problems in the Baltic Region. The systems-analysis approach and international cooperation are strongly emphasized as means which can make sustainable development of such basins possible. Subjects discussed were: systems analysis in natural resources management, Baltic basin geology and chemistry, regional management, forests and agriculture, ecosystems and fishing activities, regional development and environmental issues, decision support systems for environmental planning, and decision support for water management. The papers combined ecosystem modelling with the systems approach focusing on both management and decision-making problems. The seriousness of the environmental problems in the Baltic Region and the need to improve the management of the natural resources of this region was emphasized. International cooperation and action is necessary. The following plan of action was drawn up: To continue holding conferences on the subject. An international network dealing with questions of analysis, monitoring, modelling and managerial solution for national and international problems should be established. The participants at the Conference should, in their own contries inform politicians, decision-makers, other researchers and the public about the above-mentioned plans. (AB).

23803 (NEI-DK–264, pp. 11-21) **The role of systems analysis in environmental and natural resources management.** Vidal, R.V.V. (The Institute of Mathematical Statistics and Operations Research, The Technical University of Denmark, Lyngby (Denmark)). Technical Univ. of Denmark, Lyngby (Denmark). Inst. of Mathematical and Operations Research. 1989. (CONF-8809459–: Conference on the systems analysis approach to environmental and natural resources management in the Baltic region, Gdansk (Poland), 26-29 Sep 1988). In *Proceedings of the conference on the systems analysis approach to environmental and natural resources management in the Baltic region.* Order Number DE90760200. Available from NTIS (US Sales Only), PC A13/MF A01.

The purpose of this paper is two-fold: - to make the systems analysis community aware of the importance of dealing with the management of the environment and the natural resources, and - to inform the "environmentists" of the possibilities of applying systems analysis to cope with complex large scale problems. Finally,

the paper also suggests some projects emphasizing the practice of systems analysis with social responsability. (author).

23804 (NEI-DK–264, pp. 29-47) **The coastal seas governance project - an international comparative analysis of stressed coastal systems.** Jansson, B.-O. (Asko Laboratory, Institute of Marine Ecology, University of Stockholm (SE)). Technical Univ. of Denmark, Lyngby (Denmark). Inst. of Mathematical and Operations Research. 1989. (CONF-8809459–: Conference on the systems analysis approach to environmental and natural resources management in the Baltic region, Gdansk (Poland), 26-29 Sep 1988). In *Proceedings of the conference on the systems analysis approach to environmental and natural resources management in the Baltic region.* Order Number DE90760200. Available from NTIS (US Sales Only), PC A13/MF A01.

The coastal seas of the ocean constitute "the life support system" of the marine resources, and the economic and social activities of more than half of the world's population. They are the first areas of the sea to receive the waste products of man's exploitations of the natural resources. Areas in different political and geographical climates show similar symptoms of stress. The aim of the present study is to clarify how policy and management decisions are made in order to find mechanisms whereby scientists, managers and politicians can work to attain long-term solutions of environmental problems. The project team incorporating scientists, lawyers, land-use planners, environmental economists and journalists selected four major, coastal areas for data collection and site visits: the Cheasapeake Bay, the Baltic Sea, the North Sea and the Setonaikai (The Inland Sea of Japan). Three aditional systems: The Straits of Malacca, the South China Sea and the estuary-lagoon complex outside Sao Paulo, Brazil were also considered using written information. About 125 people were interviewed, comprising scientists, managers-administrators, politicians-political analysts, citizien groups and lawyers. Ca 260 written submissions were provided to the site visits teams and opened for creative analyses through frank and lively discussions. Our preliminary results are summarized in 10 findings and recomendations which reflect: 1. The need for an event for arising environmental issues. 2. The necessity of considering the total system through trans-disciplinary analyses. 3. The different power situation of the Scientific community in the various areas. 4. The different degree of public participation and pressure. 5. The different effects of laws versus social contracts in improving environmental decisionmaking. (author) 15 refs.

23805 (NEI-DK–264, pp. 49-84) **Integrated regional development of the Baltic region towards the sustainability of its ecosystem: A platform for thinking. .** Straszak, A. (Systems Research Institute, Polish Academy of Sciences, Warsaw (PL)); Owsinski, J.W.; Kairiukstis, L. Technical Univ. of Denmark, Lyngby (Denmark). Inst. of Mathematical and Operations Research. 1989. (CONF-8809459–: Conference on the systems analysis approach to environmental and natural resources management in the Baltic region, Gdansk (Poland), 26-29 Sep 1988). In *Proceedings of the conference on the systems analysis approach to environmental and natural resources management in the Baltic region.* Order Number DE90760200. Available from NTIS (US Sales Only), PC A13/MF A01.

The paper presents a systemic framework for the assessment of the current state and future development of the Baltic ecosystem as an integral part of a broader Baltic region system involving social, economic and ecological aspects. The paper formulates and adresses the following questions: with respect to what aspects is this region a system? How do various systemicity reaches overlap? How can be systemic behaviour rectified and /or improved, special attention being paid to inter-system synergy? The focus is on the resource and ecological system of Baltic, as the potentially generative one for the other systemic structures. It is shown, though, that these other structures are not adequate to the generative one, and that this inadequacy impinges on both the economic and ecological performance. Thus, it is proposed that economic and social activities within the Baltic region should match better the variety of its resource and ecological substratum, thereby allowing smoother and more rapid development of the region and presservation of the sustainability of this devleopment. Examples range from economic cooperation and transport to tourism and recreation, and nature protection. (author).

23806 (NEI-DK–264, pp. 87-100) **Ecological and economic models of the island of Gotland and the Baltic sea basin.** Jansson, A. (Asko Laboratory, Institute of Marine Ecology and Natural Resource Management, University of Stockholm (SE)). Technical Univ. of Denmark, Lyngby (Denmark). Inst. of Mathematical and Operations Research. 1989. (CONF-8809459–: Conference on the systems analysis approach to environmental and natural resources management in the Baltic region, Gdansk (Poland), 26-29 Sep 1988). In *Proceedings of the conference on the systems analysis approach to environmental and natural resources management in the Baltic region.* Order Number DE90760200. Available from NTIS (US Sales Only), PC A13/MF A01.

This paper presents results from a combined ecological, economic regional analysis of the island of Gotland, including models of agriculture, water quality and energy. Some of the models can be used to suggest trends or possible optimum solutions for economic development while others were designed to answer particular questions on environmental impact and constraints. From lessons learned during the Gotland study it appears that the relationships of natural resource management to economics in the Baltic region should be considered at the level of the Baltic Sea catchment area, which is therefore suggested as a useful framework for data gathering, modelling and research cooperation. (author) 15 refs.

23807 (NEI-DK–264, pp. 113-125) **On the use of hierarchical optimization in aquatic ecosystem.** Berezinski, M. (Systems Research Institute, Polish Akademy of Sciences, Warsaw (PL)); Petriczek, G. Technical Univ. of Denmark, Lyngby (Denmark). Inst. of Mathematical and Operations Research. 1989. (CONF-8809459–: Conference on the systems analysis approach to environmental and natural resources management in the Baltic region, Gdansk (Poland), 26-29 Sep 1988). In *Proceedings of the conference on the systems analysis approach to environmental and natural resources management in the Baltic region.* Order Number DE90760200. Available from NTIS (US Sales Only), PC A13/MF A01.

In the paper hierarchical approach to the problem of ecological water systems control is presented. The model describes interactions between components of aquatic ecosystem (phytoplankton and zooplankton) and wastewater conditioning these components evolution. The model concerns lakes only. It is assumed, that a growth of plant and animal organisms in lakes depends on the pollutant quality coefficient such as various forms of phosphorus, nitrogen and dissolved oxygen. The model consists of a number of submodels describing variations of some selected quality coefficients as well as variations in phytoplankton and zooplankton populations. The following processes are considered: growth and mortality of organisms, assimilation of nonorganic nutrients in growth processes and organic nutrients sedimentation. Phytoplankton and zooplankton changes are described by the system of ordinary differential equations with growth and respiration coefficients as parameters. The coefficients are considered to be functions of phosphorus and nitrogen concentration. Submodels of concentration changes of water quality indices reflect both physical and biochemical processes in water. The model objective is to determine such a strategy for waste loads discharges which quarantees ecological equilibrium in the lake. Because there are interconnections between particular sub- models it is quite natural to apply hierarchical structure control for the global model under consideration. (author).

23808 (NEI-DK–264, pp. 129-143) **Implications of forest decline for the Polish forest sector.** Wiesik, J. (Faculty of Agricultural and Forestry Engineering, Agriculture Academy of Warsaw (PL)); Wylezinski, A.T.; Nilsson, S.; Duinker, P. Technical Univ. of Denmark, Lyngby (Denmark). Inst. of Mathematical and Operations Research. 1989. (CONF-8809459–: Conference on the systems analysis approach to environmental and natural resources management in the Baltic region, Gdansk (Poland), 26-29 Sep 1988). In *Proceedings of the conference on the systems analysis approach to environmental and natural resources management in the Baltic region.* Order Number DE90760200. Available from NTIS (US Sales Only), PC A13/MF A01.

The present paper gives a description of preliminary results from a study carried out by the Department of Forestry Engineering of Warsaw Agricultural Academy in cooperation with the Forest Study of the Biosphere Project at the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria. The overall objectives of the study are to take a national perspective in building scenarios of the possible future courses of the Polish forests and wood industry under different assumptions about forest decline, and to examine the range of management strategies that could be implemented to cope with the problems continued forests decline might pose. The study consists of a number of strongly linked components including among the other: simulation and optimization models, as well as a "policy exercise" - an approach developed at IIASA for bringing scientists and policy-makers together for intensive interaction and mutual learning about shared problems. (author).

23809 (NEI-DK–264, pp. 145-161) **Analysis of forests resources dynamics; tendencies in the Baltic area of the USSR.** Mizaras, S. (Lithuanian Research Institute of Forestry, Lithuania (SU)); Kairiukstis, L.; Balcevitsh, L.; Stravinskiene, V. Technical Univ. of Denmark, Lyngby (Denmark). Inst. of Mathematical and Operations Research. 1989. (CONF-8809459–: Conference on the systems analysis approach to environmental and natural resources management in the Baltic region, Gdansk (Poland), 26-29 Sep 1988). In *Proceedings of the conference on the systems analysis approach to environmental and natural resources management in the Baltic region.* Order Number DE90760200. Available from NTIS (US Sales Only), PC A13/MF A01.

Forest resources dynamic as well as tendencies of forest decine attributed to air pollution in the Baltic area at the USSR on the pattern of Lithuanian is presented in the paper. A set of models for perspective analysis of forest resource reproduction is given here. Possible scenaries of forest dynamics, including air pollution consideration, are shown. A complex of measures taken in Lithuania to prevent forest decline is described. (author).

23810 (NEI-DK–264, pp. 219-230) **A comprehensive assessment of the air pollution level: For the purposes of environmental planning.** . Kallaste, T. (Institute of Economics, Academy of Sciences ESSR, Tallinn (SU)). Technical Univ. of Denmark, Lyngby (Denmark). Inst. of Mathematical and Operations Research. 1989. (CONF-8809459–: Conference on the systems analysis approach to environmental and natural resources management in the Baltic region, Gdansk (Poland), 26-29 Sep 1988). In *Proceedings of the conference on the systems analysis approach to environmental and natural resources management in the Baltic region.* Order Number DE90760200. Available from NTIS (US Sales Only), PC A13/MF A01.

The paper discusses methodological problems of integral assessment of atmospheric air pollution. A navel approach to generalized, comprehensive assessment of pollution considering the concept of different hazardousness of pollutants to the human organism to case of equal violations of standards in introduced. A technique for finding a synthetic comprehensive index, the so-called air pollution index, and possibilities of its practical application by environmental management aqencies are described. (author) 15 refs.

23811 (NEI-DK–264, pp. 205-218) **Decision support systems for air pollution control.** Haasis, H.-D. (Institute for Industrial Production (IIP), University of Karlsruhe (TH), Karlsruhe (DE)); Plinke, E. Technical Univ. of Denmark, Lyngby (Denmark). Inst. of Mathematical and Operations Research. 1989. (CONF-8809459–: Conference on the systems analysis approach to environmental and natural resources management in the Baltic region, Gdansk (Poland), 26-29 Sep 1988). In *Proceedings of the conference on the systems analysis approach to environmental and natural resources management in the Baltic region.* Order Number DE90760200. Available from NTIS (US Sales Only), PC A13/MF A01.

Due to the simultaneous production of final energy and air pollutants, i.e. sulphur dioxide and nitrogen oxides in stationary energy conversion units, strategies for air pollution control affect directly the corresponding optimal future energy supply structure. Therefore, when implementing air pollution control strategies, it is necessary to analyse the real energy supply structure as well as alternative emission reduction measures for the countries or regions concerned. By doing this, it is possible to use energy-environmental models, e.g. EFOM, MARKAL or MESSAGE, as decision support systems. In this report the methodological procedure for using the models as decision support systems is discussed. Moreover shiftings in the optimal future energy supply structure in European countries due to different strategies for air pollution control measures at stationary sources for the pollutants sulphur dioxide and nitrogen oxides are described using the extended Energy Flow Optimization Model EFOM, a model also in use at the Commission of the European Communities. By analysing the results obtained, optimal technical and economical measures will be derived. Using these results, an outlook is given on how to use this approach for determining optimal air pollution control strategies in the Baltic region. The main results are based on research work the authors are performing for the Commission of the European Communities, Brussels, and the European Center for Air Control Measures, Karlsruhe. (author) 12 refs.

23812 **Why the "macro-energy" models.** Devezeaux de Lavergne, J.G. (CEA, 75 - Paris (FR)); Ladoux, N. *Revue de l'Energie (France),* 40(411): 423-434 (May 1989). (In French).

The use of overview economic and energy models - here referred to as macro-energy models - has been spreading in our country for some years now, with tools such as Hermes-France, Mini-DMS-energy and Melodie-France. On the other hand, the specific energy supply or demand models are older. So it is important to assess the contribution of the former to energy decision making. The article demonstrates the advantages whenever overall energy policies are being considered, and it shows that the expected effects are perceptible at the macro-economic level. This is because macro energy models take cognizance of the behavior of economic factors (including energy demand) in reaction to parameters such as the prices of energy and non energy equipment and materials. The decision making goes beyond just arbitrating between energy products, and it is important to represent these decisions in a complete manner, therefore macro-economically. The use of such models enables a description of the multiple effects and feedbacks which the decisions taken exert on each other and they provide an energy expertise which is always coherent for each structure. This feature is essential for long term analysis.

2902 Economics and Sociology

Refer also to citation(s) 23454, 23812

23813 (DOE/S–0066P) **National Energy Strategy: A compilation of public comments: interim report.** USDOE, Washington, DC (USA). Apr 1990. 230p. Sponsored by U.S. DOE Office of the Secretary. Order Number DE90009000. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

This Report presents a compilation of what the American people themselves had to say about problems, prospects, and preferences in energy. The Report draws on the National Energy Strategy public hearing record and accompanying documents. In all, 379 witnesses appeared at the hearings to exchange views with the Secretary, Deputy Secretary, and Deputy Under Secretary of Energy, and Cabinet officers of other Federal agencies. Written submissions came from more than 1,000 individuals and organizations. Transcripts of the oral testimony and question-and-answer (Q-and-A) sessions, as well as prepared statements submitted for the record and all other written submissions, form the basis for this compilation. Citations of these sources in this document use a system of identifying symbols explained below and in the accompanying box. The Report is organized into four general subject areas concerning: (1) efficiency in energy use, (2) the various forms of energy supply, (3) energy and the environment, and (4) the underlying foundations of science, education, and technology transfer. Each of these, in turn, is subdivided into sections addressing specific topics — such as (in the case of energy efficiency) energy use in the transportation, residential, commercial, and industrial sectors, respectively. 416 refs., 44 figs., 5 tabs.

2903 Environment, Health, and Safety

Refer also to citation(s) 23381, 23382, 23383, 23384, 23385, 23386, 23387, 23388, 23389, 23390, 23391, 23392, 23495, 23496, 23497, 23498, 23502, 23528, 23583, 23584, 23587, 23659, 23660, 23661, 23662, 23663, 23664, 23802, 23804, 23830, 24160, 24373, 24376, 24377, 24378, 24396, 24399, 24400, 24401, 24402, 24403, 24404, 24405, 24406, 24407, 24408, 24409, 24411, 24412, 24425, 24427, 24441, 24442, 24443, 24444, 24445, 24446, 24447, 24448, 24450, 24451, 24458, 24459, 24460, 24461, 24462, 24463, 24464, 24465, 24466, 24467, 24468, 24469, 24470, 24471, 24472, 24473, 24474, 24475, 24477, 24478, 24479, 24482, 24483, 24484, 24485, 24487, 24491, 24492, 24493, 24494, 24495, 24496, 24497, 24498, 24499, 24500, 24501, 24502, 24503, 24504, 24505, 24506, 24507, 24508, 24509, 24510, 24511, 24512, 24513, 24514, 24515, 24516, 24520, 24521, 24522, 24523, 24524, 24525, 24526, 24527, 24531, 24532, 24534, 24536, 24537, 24540, 24541, 24543, 24544, 24545, 24548, 24554, 24555, 24557, 24558, 24559, 24560, 24561, 24562, 24563, 24564, 24565, 24566, 24567, 24568, 24569, 24570, 24571, 24572, 24573, 24574, 24575, 24576, 24577, 24578, 24579, 24580, 24581, 24582, 24583, 24584, 24585, 24586, 24587, 24588, 24589, 24590, 24591, 24592, 24593, 24594, 24595, 24597, 24598, 24599, 24600, 24601, 24602, 24603, 24604, 24605, 24606, 24607, 24608, 24609, 24610, 24611, 24612, 24613, 24614, 24615, 24616, 24617, 24618, 24619, 24620, 24621, 24622, 24623, 24624, 24625, 24626, 24627, 24628, 24629, 24630, 24631, 24632, 24633, 24634, 24635, 24636, 24637, 24638, 24639, 24640, 24641, 24642, 24643, 24644, 24645, 24646, 24647, 24648, 24649, 24650, 24651, 24652, 24653, 24654, 24655, 24656, 24657, 24658, 24659, 24660, 24661, 24662, 24663, 24664, 24665, 24666, 24667, 24668, 24669, 24670, 24671, 24672, 24673, 24674, 24675, 24676, 24677, 24678, 24679, 24680, 24681, 24682, 24683, 24684, 24685, 24686, 24687, 24688, 24689, 24690, 24691, 24692, 24693, 24694, 24695, 24696, 24697, 24698, 24699, 24748, 24758, 24759, 24760, 24761, 24762, 24763, 24764, 24765, 24766, 24767

23814 (LLNL-M–243-Vol.1) **A guide to performing and documenting safety analyses: Volume 1.** Hallinan, E.J. Lawrence Livermore National Lab., CA (USA). Feb 1989. 89p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008687. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

Safety analysis has been one of the most volatile technical fields in recent times. In fact, some have questioned whether it qualifies as a "technical" field. Controversies have arisen because: safety analysis results are prophesies and not exact predictions; most of the results are qualitative rather than quantitative; exact quantitative criteria for comparison are scarce. Terms such as "unlikely" for event frequency and "major" for consequences are frequently used. These terms are hard to define and assess; data for predictions is also scarce, may not exactly apply, and is subject to large uncertainties; most accidents can involve human errors, and human response cannot be accurately estimated; safety analysis is a relatively new field with ever-changing rules and requirements; relatively few personnel have been trained in safety analysis techniques and have operations experience, both in the organizations that perform the safety analyses and those that regulate how safety analyses are to be done; safety analysis budgets are usually controlled by line organizations that must also design, build, and operate the facility. Line organizations usually perceive such safety analysis costs as nonproductive and thus provide only minimum funding; in general, radiological impacts are overemphasized, and nonradiological impacts are superficially treated. This leads to inconsistencies in analyzing and designing against hazards; and safety analyses are not performed, reviewed, or documented consistently throughout the US Department of Energy (DOE) complex. 4 refs., 9 figs., 12 tabs.

23815 (LLNL-M–243-Vol.2) **A guide to performing and documenting safety analyses: Volume 2, Safety analysis example.** Hallinan, E.J. Lawrence Livermore National Lab., CA (USA). Mar 1989. 60p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008688. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This is Volume 2 of M-243, A Guide to Performing and Documenting Safety Analyses. Volume 1 establishes a logical framework for satisfying safety analysis requirements of the DOE Safety Analysis and Review System (SARS). (A complete listing of acronyms used in these documents is given in Volume 1.) This framework helps ensure that acceptable safety analyses are consistently and efficiently prepared and documented. The detailed example included here will demonstrate how the guidelines in Volume 1 can help safety analysts and managers achieve their goals by illustrating the process and the result. The example has been chosen from a familiar operation to highlight the process and sample report without getting lost in explaining technical details or creating a forum for disagreements over fine points rather than concentrating on approach and presentation. (The example would really fall into the category of "routinely accepted" and not need a safety analysis as defined by DOE Order 5480.1B and 5481.1B. However, for the purposes of this document, let us assume that a safety analysis is needed for the example.) Although this volume reviews basic concepts from Volume 1 that will be needed for the example, consult the main text for more detailed information. 7 figs., 18 tabs.

23816 (NEI-DK–284) **Realization of the green city project in the Svendsgade area: Final report.** Slagelse Kommune (Denmark); Groen by-Kontoret, Slagelse (Denmark). [1989]. 76p. (In Danish). Contract TR-88.566. Order Number DE90760246. Available from NTIS (US Sales Only), PC A05/MF A01.

Although it proved difficult, perhaps because of social conditions in the area, to interest and activate the local inhabitants, the initiators successfully convinced the local politicians in Slagelse, Denmark, of the advantages of improving the environmental quality of a certain area of the town. Pioneer work involved a series of lectures, and relevant educational and journalistic activities. These were considered of significant value, and it is concluded that information centers aimed at the promotion of improved environmental quality in urban areas should be instigated throughout the country. Further activities, in relation to the initiation of the use of solar heating systems and wind power, of the reduction and management of municipal waste and the building of a housing complex for elderly people, are described. (AB).

23817 (NEI-NO–102, pp. 30) **Guidelines for subsea production systems.** Haaland, J. Norsk Petroleumsforening, Oslo (Norway). 1987. (In Norwegian). (CONF-8703333–: Installation and maintenance of subsea production system, Haugesund (Norway), 16-18 Mar 1987). In *Installation and maintenance of subsea production systems, Haugesund (Norway), 16-18 Mar 1987.* Order Number DE90760265. Available from NTIS (US Sales Only), PC A20/MF A01.

The paper deals with the recommendations given for the development and operation of subsea production systems on the Norwegian continental shelf. The systems discussed in this connection are supporting/safety structures, subsea-completed wells for production and/or injection, x-mas connected valves and pipes, electric systems, safety of processing, pipelines and risers, and also manned subsea operations.

23818 (NEI-NO–102, pp. 11) **Governmental standpoint-existence of regulation: Question of maintenance criteria. .** Haaland, J. Norsk Petroleumsforening, Oslo (Norway). 1987. (In Norwegian). (CONF-8703333–: Installation and maintenance of subsea production system, Haugesund (Norway), 16-18 Mar 1987). In *Installation and maintenance of subsea production systems, Haugesund (Norway), 16-18 Mar 1987.* Order Number DE90760265. Available from NTIS (US Sales Only), PC A20/MF A01.

The paper focuses on the state of regulations and maintenance criteria for subsea production systems on the Norwegian continental shelf. The governmental standpoint in this field is discussed.

23819 (NEI-NO–102, pp. 18) **The Statpipe pipelines: Experiences with the inspection of the Statpipe pipelines - Presentation of the computer system SITRAS-R. .** Olsen, O.A. Norsk Petroleumsforening, Oslo (Norway). 1987. (In Norwegian). (CONF-8703333–: Installation and maintenance of subsea production system, Haugesund (Norway), 16-18 Mar 1987). In *Installation and maintenance of subsea production systems, Haugesund (Norway), 16-18 Mar 1987.* Order Number DE90760265. Available from NTIS (US Sales Only), PC A20/MF A01.

The paper deals with the regulation regarding inspection routines for the Statpipe pipelines on the Norwegian continental shelf. The computer program SINTRAS-R is used in the on-line inspection. 1 fig.

23820 (NEI-NO–103) **Coefficients of discharge: Survey of coefficients for the discharge to air and methods of calculation.** Rosland, A. Statens Forurensningstilsyn, Oslo (Norway). 1987. 104p. (In Norwegian). Order Number DE90760285. Available from NTIS (US Sales Only), PC A06/MF A01.

The report gives a collected survey of coefficients for the discharge of SO_2, NO_x, VOC (Volatile Organic Components), CO,Pb, and soot from various air polluting sources. The discharge from stationary combustion, industrial processes, mobile sources, refuse combustion, evaporation by storing and use of petrol, solvents, and evaporation of terpenes from wood are compared. The given coefficients are based on Norwegian and foreign references. In the appendix the collection- and calculation methods are presented in detail. 7 figs., 52 tabs., 41 refs.

23821 (NILU/OR–27/89) **Stack heights for small oil fired boilers.** Boehler, T. Norsk Inst. for Luftforskning, Lillestroem (Norway). Apr 1989. 9p. (In Norwegian). Order Number DE90760260. Available from NTIS (US Sales Only), PC A02/MF A01.

The Norwegian Institute for Air Research has performed dispersion calculations for evaluation of lowest slack height for oil fired boilers of capacity up to 5 MW. The evalution has been carried out for three different types of oil with respect to contents of sulfur, and two proposals for directives for contents of sulfur dioxide in the outdoor air. The results show that the building dimensions are decisive for the choice of slack height for oil types with sulfur content up to 0.5%. 2 ref., 3 tabs.

23822 (PB–90-138744/XAB) **Environmental audit program design guidelines for federal agencies.** Edward, J.R.; Young, B.M. Booz, Allen and Hamilton, Inc., Bethesda, MD (USA). Aug 1989. 171p. Available from NTIS, PC A08/MF A01.

The goal of environmental management is to reduce environmental pollution and minimize risks associated with a facility's production, operations and maintenance. An environmental management program oversees the environmental functions within an agency, generally providing guidance and technical support throughout the entire organization. An environmental audit program is a critical component of an agency's ongoing environmental management program. Auditing increasingly is being used as a systematic method for verifying compliance with applicable statutes and regulations, evaluating the effectiveness of environmental management systems already in place, and identifying unregulated risks present at a facility. In essence, environmental auditing provides the data for a facility or agency to prepare a report card to ensure that the goals and objectives of their ongoing environmental program are achieved. The Environmental Protection Agency (EPA) defines environmental auditing as a systematic, documented, periodic and objective review of facility operations and practices related to meeting environmental requirements. In addition, EPA policy encourages all Federal agencies to develop auditing programs and offers technical assistance to help Federal agencies design audit programs. The guidance document is one means by which EPA is following through on its commitment to provide such assistance to other Federal agencies.

23823 (PB–90-153875/XAB) **Management review of the Superfund program.** Environmental Protection Agency, Washington, DC (USA). 1989. 186p. Available from NTIS, PC A09/MF A01.

Also available from Supt. of Docs. See also PB–90-153883.

Contents: a clear strategy for superfund; strengthening enforcement and maximizing responsible party work at superfund sites; accelerating and improving remedial action; bringing innovative technologies to bear on pollution at superfund sites to strengthen remedy selection; an aggressive program of community involvement; management and administration: freeing up the skills and tools to do the job; accounting for achievement: communicating progress to the public.

23824 (PB–90-153883/XAB) **Management review of the Superfund program: Implementation plan.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 21 Sep 1989. 173p. (EPA–540/8-89/009). Available from NTIS, PC A08/MF A01.

Also available from Supt. of Docs. See also PB–90-153875.

The Superfund 90-Day Study set forth a comprehensive long-term strategy for the Superfund Program. The basic elements of the strategy are to: Control acute threats immediately; Deal with the worst sites and worst problems first; Carefully monitor and maintain sites over the long term; Emphasize enforcement to induce private-party cleanup; Seek new technologies for more effective cleanup; Improve the efficiency of program operations; and Encourage full participation by communities.

23825 (PB–90-153891/XAB) **Removal cost-management manual.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. Apr 1988. 205p. (OSWER-DIRECTIVE–9360.0-02B). Available from NTIS, PC A10/MF A02.

Also available from Supt. of Docs.; Portions of this document are not fully legible.

The manual is designed to provide comprehensive cost management procedures for use by the Environmental Protection Agency (EPA) at removal actions authorized under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund). Specifically, the document should be used by the On-Scene Coordinator (OSC) and other on-site personnel designated by the OSC when performing cost management activities at a Superfund removal site.

2904 Energy Resources

Refer also to citation(s) 23802

23826 (PB–90-148313/XAB) **Analysis of the water situation in the United States: 1989-2040. A technical document supporting the 1989 USDA Forest Service RPA (Resources Planning Act) assessment. Forest Service general technical report.** Guldin, R.W. Forest Service, Fort Collins, CO (USA). Rocky Mountain Forest and Range Experiment Station. Sep 1989. 188p. (FSGTR-RM–177). Available from NTIS, PC A09/MF A01.

The report includes: the current water resource situation; the demand situation for water; the supply situation for water; comparison of projected demand and supply; economic, environmental, and social implications of projected supply and demand; opportunities to improve the management of water and related forest and rangeland resources; obstacles to improving the management of water and related forest and rangeland resources.

23827 (PB–90-150582/XAB) **Mineral planning in Great Britain and its relevance to the American mining industry. Final report, 1 December 1980-31 May 1981.** Saperstein, L.W. Pennsylvania State Univ., University Park, PA (USA). Dept. of Mining Engineering. 1989. 154p. Available from NTIS, PC A08.

Portions of this document are not fully legible.

In the United States, approval of surface coal mine permits became more complex with the imposition of certain additional and relatively untested requirements by the Surface Mining Control and Reclamation Act of 1977. Sections of the Act contain substantial pre-mining land-use planning requirements. The British system has been chosen for comparative study. All mining permits are granted in Great Britain within an overall land-use planning system. The British planning system is summarized with emphasis placed on minerals. Although planning systems are a well-described subject, little documentation addresses the special problems of mining companies. The first study helps to fill this gap.

2905 Research, Development, Demonstration, and Commercialization

Refer also to citation(s) 23838, 23839, 23849

23828 (AFME–83-0976-Bis) **Energy-related technologies integration in developing countries.** Akrich, M.; Callon, M. Agence

Francaise pour la Maitrise de l'Energie, 75 - Paris (France). 1986. 150p. (In French). Order Number DE90761941. Available from NTIS (US Sales Only), PC A07/MF A01.

The objectives of this study were to identify the obstacles to the integration of energy technologies in developing countries and to evaluate the requisite conditions for their integration; three examples are studied: introduction of photovoltaic systems for lighting in Senegal and Ivory Coast, introduction of photovoltaic systems for electrification of remote areas in Polynesia, and diffusion of generator sets in rural area in Senegal.

23829 (ANL/ESD/TM–3) **Catalog of organizations that assist inventors: Activities and services, Edition 2.** Argonne National Lab., IL (USA). Energy Systems Div. Jan 1990. 154p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. Order Number DE90008158. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

Several different types of national, state, and local organizations and programs, both public and private, assist independent inventors. The number of such organizations and programs is growing. Most of them work independently of each other, often without knowledge of each other. The staff of the Energy-Related Inventions Program (ERIP) at the US Department of Energy (DOE) realized that: many of these organizations are quite capable of doing innovative things to assist inventors, and many have extensive, highly original programs aimed at organizing the inventor's social world; no mechanism has existed for these organizations to communicate with each other; evaluation of organizational success or failure in assisting inventors has been lacking; and some of these organizations could benefit from technical assistance and small amounts of financial assistance to encourage innovation in assisting inventors.

23830 (CEC–90008595) **Investing in California's energy future: A report to the Legislature on the Energy Technologies Advancement Program: The first five years.** Smith, M.; Simons, G.; Taylor, S.; Eden, D. California Energy Resources Conservation and Development Commission, Sacramento, CA (USA). [1990]. 35p. Sponsored by California Energy Commission. (P–500-89-012). Available from OSTI; California Energy Commission, 1516 Ninth Street, Sacramento, CA 95814-5512.

This is a report by the California Governor to state Legislature on energy resources in California's future. The following is an exerpt form Governor Deukmejian's letter to the legislature. We in government have an important role in this effort. We can affect the future of our state by the policies and programs that we undertake today. We can learn from our Japanese and European competitors who strongly support domestic energy research and development efforts. The Energy Technologies Advancement Program was begun to assist California's energy industry in continuing as the world's energy technology leader well into the twenty-first century. This report summarized the benefits of the ETAP after its first five years.

23831 (DOE/ER–0445P) **1989 review of the basic energy sciences program of the Department of Energy.** USDOE Office of Energy Research, Washington, DC (USA). Feb 1990. 108p. Sponsored by U.S. DOE Energy Research. Order Number DE90008000. Available from NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.

This report of the Basic Energy Sciences Advisory Committee contains overviews, findings, and recommendations in the various energy research areas. (JEF)

23832 (ETDE/OA–37) **International Energy Agency Energy Technology Data Exchange: Annual report, 1989.** Energy Technology Data Exchange, Oak Ridge, TN (USA). [1989]. 23p. Sponsored by Energy Technology Data Exchange. Order Number DE90008596. Available from NTIS, PC A03/MF A01 - OSTI.

This is the annual report of the Energy Technology Data Exchange program of the International Energy Agency. A review of programs and budgeting is given in overview fashion. (JEF)

23833 (PNL-SA–17399) **Technology transfer at Pacific Northwest Laboratory.** Pacific Northwest Lab., Richland, WA (USA). Oct 1989. 43p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. Order Number DE90008610. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Scientific discoveries, engineering developments, and innovative applications of technology create new pathways of economic opportunity for new processes and products. The Pacific Northwest Laboratory (PNL), other federal laboratories, and federally funded research and development efforts are at the forefront in such trail-blazing ventures. PNL's programs of research, engineering development, and creative problem solving enhance the nation's technology base and strengthen its economy. Putting technology to work has been a pivotal feature of the management and operation of PNL since Battelle Memorial Institute was awarded the management and operation of the Laboratory in 1965. Under a unique contractual agreement with the US Department of Energy, PNL performs research and development work for both the government and the private sector. This arrangement has resulted in an effective means for domestic transfer of federally funded technology. At PNL, the Technology Transfer program acts as a "bridge," enabling products of the Laboratory to "cross" – tailored to meet government and industry needs. The program is based on a strong Laboratory commitment to the rapid deployment of research results. This commitment is implemented through a network of collaborative interactions with agencies of national, state, and local government, with academic institutions, and with a variety of business and industrial interests. Highlights of PNL's recent technology transfer activities during 1988 are summarized in this report, which also contains an overview of program organization and methodology. Also, this document is PNL's invitation for inquiries by state, local, and municipal agencies, as well as for discussions of technology interests with representatives of US industry.

2906 Nuclear Energy

Refer also to citation(s) 23798

23834 (PB–90-146788/XAB) **DOD (Department of Defense) response to Improvised Nuclear Device (IND) Incidents. Directive.** Runner, B. Assistant Secretary of Defense (Special Operations and Low-Intensity Conflict), Washington, DC (USA). 24 Mar 1987. 10p. (DOD-D–3150.5). Available from NTIS, PC A02/MF A01.

The Directive reissues DoD Directive 3150.5, July 19, 1985, to update policies and procedures for DoD response to IND incidents, to implement the DoD technical responsibilities defined in Joint Federal Bureau of Investigation, Department of Energy and Department of Defense Agreement for Response to Improvised Nuclear Device Incidents, February 27, 1980, and Joint Department of State, Department of Energy and DoD Memorandum of Understanding for Responding to Malevolent Nuclear Threats Outside U.S. Territory and Possessions, January 28, 1982, and to amplify the direction concerning law enforcement and other associated responsibilities issued in DoD Directive 3025.12 and DoD Directive 5100.46.

23835 (PB–90-146796/XAB) **Survivability of non-strategic nuclear forces (NSNF). Directive.** Chase, E. Assistant Secretary of Defense (Atomic Energy), Washington, DC (USA). 27 Feb 1986. 8p. (DOD-D–3150.3). Available from NTIS, PC A02/MF A01.

The Directive replaces Secretary of Defense Memorandum, January 19, 1977, and establishes a DoD program to develop concepts, procedures, hardware, facilities, and training programs to ensure the survivability of both non-strategic nuclear forces (NSNF) and the forces, systems, and facilities that provide mission-critical support to NSNF. The Directive prescribes policies and responsibilities, and requires that each Military Service establish an NSNF survivability program.

23836 (PB–90-146804/XAB) **Safety studies and reviews of nuclear-weapon systems. Directive.** Gilson, J. Assistant Secretary of Defense (Atomic Energy), Washington, DC (USA). 8 Feb 1984. 14p. (DOD-D–3150.2). Available from NTIS, PC A03/MF A01.

The Directive replaces DoD Directive 5030.15. It updates the policy, responsibilities, and procedures for applying safety standards to nuclear weapons and to nuclear weapon systems, developing and processing nuclear weapon system safety rules, and

conducting safety studies and operational safety reviews of nuclear weapon systems.

2910 Conservation

Refer also to citation(s) 24144

23837 (AFME–86-91-0005-Bis) **Regulations and standards prescriptions in foreign countries, related to energy conservation.** Anon. Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). 1986. 135p. (In French). Order Number DE90761937. Available from NTIS (US Sales Only), PC A07/MF A01.

A review of the regulations and standards prescription concerning energy conservation in developed countries (Germany, Austria, Belgium, Canada, USA, France, Ireland, Italy, Luxembourg, UK and Switzerland) is presented. The subjects covered are: domestic and industrial heat pumps, heat exchangers, electro-thermal equipments, renewable energy, thermal regulators, solar equipment, electric industrial furnace, biomass digester, reverse osmosis.

2930 Policy, Legislation, and Regulation

Refer also to citation(s) 23813, 23873, 23889

2940 Fossil Fuels

Refer also to citation(s) 23486, 23527, 23798, 24354

23838 (CONF-880770– II.9-II.14) **Coal - targets of opportunity workshop, opening remarks.** Siegel, J.S. Sheladia Associates, Inc., Rockville, MD (USA). Sep 1988. From Coal - targets of opportunity workshop; Washington, DC (USA); 12-13 Jul 1988. In *Coal: Targets of opportunity workshop: Proceedings.* Order Number DE89002076. Available from NTIS, PC A12/MF A01.

The paper begins by describing three conclusions from the Energy Security Report which assessed the energy security implications of declining domestic oil production and rising oil imports. This report concluded that if the current trends continue the US will become much more dependent upon imported oil during the next decade; oil use will become concentrated in the transportation and industrial sectors; and development of alternative fuel systems and improvements in energy efficiency are the most promising means for reductions in oil consumption. The paper highlights several advancements in coal technology: coal liquefaction, integrated coal gasification combined cycles, mild gasification for coproducts production, coal-water slurries, atmospheric fluidized-bed combustion, advanced combustors, coal preparation, coal-fired diesels, and coal-fired turbines.

23839 (CONF-880770– II.15-II.17) **The government as a partner in research and development activity.** Miller, C.L. Sheladia Associates, Inc., Rockville, MD (USA). Sep 1988. From Coal - targets of opportunity workshop; Washington, DC (USA); 12-13 Jul 1988. In *Coal: Targets of opportunity workshop: Proceedings.* Order Number DE89002076. Available from NTIS, PC A12/MF A01.

This paper describes the changes in policy of the US Department of Energy regarding research and development programs it sponsors, using the Coal Technology program as an example. Since the industrial sector is now sharing in 50% or more of the costs, it is asking for greater participation in decision making. The DOE is re-evaluating patent rights, ownership of intellectual property (operating data), responsibility for technology transfer, accommodation of foreign technology, and the definition of respective roles of the DOE and the industrial participant.

2960 Electric Power

Refer also to citation(s) 23797, 23798, 23878, 23879

23840 (AFME–86-09-0036) **Households electric consumption in Ivory Coast.** Steck, D. Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). 1987. 48p. (In French). Order Number DE90761948. Available from NTIS (US Sales Only), PC A03/MF A01.

After a review of the demographic data in Ivory Coast, the national electric network and production station system is presented and the costs are evaluated; the geographic repartition of the demand is described. The various aspects of the domestic electricity demand are then examined in details: low voltage demand, domestic customer statistics, electrification rate over the country, mean consumption and rural areas data and previsions.

23841 (DOE/EIA–0540(88)) **Electric sales, revenue, and bills 1988.** USDOE Energy Information Administration, Washington, DC (USA). Office of Coal, Nuclear, Electric and Alternate Fuels. 15 Mar 1990. 228p. Sponsored by U.S. DOE Management & Administration. Order Number DE90008854. Available from NTIS, PC A11/MF A01 - GPO - OSTI; GPO Dep.

This document contains two sections. The "Background" section provides a discussion on (1) how average revenue per kilowatthour and typical net monthly bills differ; (2) the classes of electric utility ownership; and, (3) the classes of service or sectors. The "Year at a Glance" section provides a summary of pertinent statistics during the year related to sales of electricity to ultimate consumers, electric revenue from those sales, and average revenue per kilowatthour of electricity sold. 5 figs., 22 tabs.

23842 (DOE/SWP–9001) **Southwestern Power Administration 1989 annual report.** USDOE Southwestern Power Administration, Tulsa, OK (USA). [1989]. 40p. Sponsored by U.S. DOE Management & Administration. Order Number DE90008149. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Southwestern Power Administration has completed another successful year in which we met or exceeded our goals for marketing power, safely and reliably operating and maintaining our transmission system and repaying the Government's investment in the federal power system. For the eighth straight year, we improved our repayment status. Although at times it appeared we were experiencing a drought, by careful use of our banking arrangements; skillful use of the flexibility of the integrated system; and the cooperation of mother nature, who made up for the dry periods late in the season, the system was able to generate above average annual energy. This resulted in revenues that provided $22.8 million to be applied to the repayment of investment. Credit for this good record is shared with our customers, the general public, and neighboring utilities with whom we have developed and maintained a relationship in the spirit of mutual trust and cooperation. This enables us to operate under the "one utility concept" yielding substantial dividends in terms of cost efficiency, minimizing adverse environmental impacts, and providing quality, reliable electrical service. 27 figs.

23843 (EPRI-EL–6753) **Security analysis software needs: Survey results: Final report.** Virmani, S. (EPIC Engineering, Inc., Los Altos, CA (USA)); McNair, H.D. Electric Power Research Inst., Palo Alto, CA (USA); EPIC Engineering, Inc., Los Altos, CA (USA). c Mar 1990. 88p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A survey of approximately thirty (30) electric utilities in the United States determined the status of the use of Static Security Analysis programs in their Energy Control Centers. The objective of the survey was to identify strengths and weaknesses of existing applications software. This data could prove useful to the industry in selecting new areas of research and development as well as possible improvements in the current generation of security analysis programs. The survey included telephone interviews with twenty-eight (28) utilities, as well as visits to five (5) utilities. A set of twelve (12) questions, some of which had multiple parts, was prepared and used to obtain the responses. In addition, following completion of the initial survey, six (6) utilities generously agreed to provide detailed written descriptions of certain key aspects of their experiences in implementing Static Security Analysis applications. This report contains both the results of the survey and the six (6) papers prepared by the utilities. 11 tabs.

23844 (ORNL/FTR–3543) **[Surveying isolated diesel power stations in Guatemala]: Foreign trip report, February 5, 1990–February 22, 1990.** Waddle, D.B. Oak Ridge National Lab., TN (USA). 26 Feb 1990. 7p. Sponsored by U.S. Agency for International Development. DOE Contract AC05-84OR21400. Order

Number DE90008504. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

I travelled to Guatemala City, Guatemala, to lead a team of specialists to study the operating, administrative, and management efficiency of isolated diesel power plants, operated by Instituto Nacional de Electrificacion (INDE). The study is part of a global initiative managed jointly by the Agency for International Development and the World Bank. The power plants were audited, including INDE's largest isolated diesel station, and two, much smaller municipal and privately owned stations. I returned to Oak Ridge on February 22, 1990.

2990 Unconventional Sources and Power Generation

Refer also to citation(s) 23658, 23816

23845 (NEI-DK-268) **Organic wastes incorporated in a cycle. Utilization of organic wastes and manure fertilizers in the borough of Aarhus. Part 1: Explanation.** Nellemann (N.) og Partnere A/S, Aalborg (Denmark); Miljoesamarbejdet i Aarhus (Denmark). 1989. 97p. (In Danish). Contract TR-86.676. Order Number DE90760217. Available from NTIS (US Sales Only), PC A05/MF A01.

Suggestions for the planning of utilization of organic wastes within the borough of Aarhus, Denmark, are given. They can, for example, be used in the production of energy. Straw and wood can be used as fuel, and manures and some other types of organic wastes can be used in biomass conversion plants for the production of methane. Other suggestions, such as the production of hydrogen, ethanol and heat (from composting) are given but it is concluded that they may not be so realistic currently. Sources for the useful kinds of organic wastes, and handling methods, are described in some detail. (AB).

23846 (NEI-DK-269) **Organic wastes incorporated in a cycle. Utilization of organic wastes and manure fertilizers in the borough of Aarhus. Part 2: Survey.** Nellemann (N.) og Partnere A/S, Aalborg (Denmark); Miljoesamarbejdet i Aarhus (Denmark). 1989. 75p. (In Danish). Contract TR-86.676. Order Number DE90760218. Available from NTIS (US Sales Only), PC A04/MF A01.

A survey of supply sources of manure fertilizers and household waste, the amount and quality, is necessary in order to construct a plan which involves the inclusion of organic wastes in a controlled cycle. The quality is evaluated in relation to what the wastes are to be used for. This survey is relevant to the borough of Aarhus. (AB).

23847 (NEI-DK-270) **Organic wastes incorporated in a cycle. Utilization of organic wastes and manure fertilizers in the borough of Aarhus. Part 3: Planning.** Nellemann (N.) og Partnere A/S, Aalborg (Denmark); Miljoesamarbejdet i Aarhus (Denmark). 1989. 61p. (In Danish). Contract TR-86.676. Order Number DE90760219. Available from NTIS (US Sales Only), PC A04/MF A01.

Methods of planning in relation to the utilization of organic waste in the borough of Aarhus are presented. The legal background is described and three draft plans in relation to an ecosystem operational economy and thrift are explained. (AB).

23848 (NEI-DK-271) **Organic wastes incorporated in a cycle. Utilization of organic wastes and manure fertilizers in the borough of Aarhus. Part 4: Supplements.** Nellemann (N.) og Partnere A/S, Aalborg (Denmark); Miljoesamarbejdet i Aarhus (Denmark). 1989. 98p. (In Danish). Contract TR-86.676. Order Number DE90760220. Available from NTIS (US Sales Only), PC A05/MF A01.

A collection of supplements in relation to the utiliation of organic wastes in the borough of Aarhus. These supplements contain specific data in relation to the planned project. (AB) 69 refs.

30 DIRECT ENERGY CONVERSION

3005 Fuel Cells

Refer also to citation(s) 23263, 23284

23849 (DOE/FE-0106P) **Fuel cell systems program plan, FY 1990.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of the Deputy Assistant Secretary for Oil, Gas, Shale and Special Technologies. Oct 1989. 40p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90008178. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A principal goal of the Office of Fossil Energy is to increase the utilization of domestic fuels in an environmentally benign manner, through the development and transfer to the private sector of advanced energy conversion technology. Successful efforts to achieve this goal contribute to the stability and reliability of reasonably priced energy supplies, enhance the competitiveness of domestic fuels and energy technologies in domestic and international markets, and contribute to the development of cost effective strategies for control of acid rain and global warming. Several advanced energy conversion technologies are now under development by DOE which can help to achieve these objectives. Fuel cells are among those technologies. This report briefly describes fuel cell technology and the program plan of US DOE fuel cell program.

23850 (NEI-DK-276) **A report on the progressing of the FC project at KLA.** Xiao Gang. Danmarks Tekniske Hoejskole, Lyngby (Denmark). Kemisk Lab. A. Aug 1989. 78p. Contract ENS-151/89-32. Order Number DE90760229. Available from NTIS (US Sales Only), PC A04/MF A01.

EFP-89.

The fuel cell project at Chemistry Department A at the Technical University of Denmark, started in the summer of 1988 with the purpose of developing phosphoric acid fuel cells. The early attempts with glass type cell components were described in a previous report. More work has been done since then to follow the-state-of-the-art of phoshporic acid fuel cells, including the improvement of the cell design and the preparation of the Pt supported carbon electrodes. The work also dealt with the modification of the electrolyte. Therefore some related electrolytes and mixtures have been tried in the cells. For comparison, cells were also run with some promising fuels and fuel mixtures other than H2. A attempt was made to use solid proton conductor electrolyte. A survey and some considerations on modifying phosphoric acid fuel cells electrolytes are included in this report. The preparation of the Pt supported carbon electrodes and the SEM examination of some electrode materials are described. (AB) 26 refs.

23851 (NEI-DK-282) **Development of fuel cells based on phosphoric acid.** Olsen, C. Danmarks Tekniske Hoejskole, Lyngby (Denmark). Kemisk Lab. A. Apr 1989. 102p. (In Danish). Contract ENS-151/89-32. Order Number DE90760241. Available from NTIS (US Sales Only), PC A06/MF A01.

EFP-89.

The aim was to discover additives to the traditional electrolytes (85% H3PO4) in order to achieve a faster electrode kinetic and to reduce excess voltage in relation to the electrodes. A measuring model was constructed. The highest open voltage measured was 995mV at 146 c, and the highest diffusion limited current density was 10 mA/cm2 in relation to an operation temperature of 50 deg. C. These measurements show that the diffusion limited current density of the electrodes has been improved at a rate of 200 in relation to other electrodes which the laboratory has worked with, but that this improvement should be furthered to the rate of a further 10 to achieve optimization. (AB) 45 refs.

23852 (PB-90-148065/XAB) **Impact of fundamental technical improvements to natural gas fuel cells. 1989 Annual Report.** Maricle, D.L. International Fuel Cells Corp., South Windsor, CT (USA). Nov 1989. 18p. (FCR-10570A). Available from NTIS, PC A03/MF A01.

The original objective of this program is to identify the fundamental limitations of the phosphoric acid and solid oxide fuel cells and define research paths for solution of the high priority limitations. During the report period work was conducted on phosphoric acid,

polymer and solid oxide electrolyte systems. Phosphoric acid improvements in the range of 50-300 mV were investigated. Research projects in the areas of alternative electrolyte, electrodes and catalysts were determined to provide the largest improvements in cell performance. The primary advantage of the polymer electrolyte design was identified to be cell performance. As much as a 50 mV improvement is considered possible over the current phosphoric acid system. Major limitations of the polymer electrolyte systems are low operating temperature, need for high humidity operation and high cost. Work was initiated during the report period in the solid oxide system. Principal limitations were identified to be required use of very fragile ceramic materials, use of high temperature ancillary equipment which has been found to be costly and unreliable, limited contact area between the solid electrolyte and the electro catalyst and nickel as the anode material. A list of research paths were identified which include identification of lower temperature oxide electrolytes, development of new low resistance interconnect material, identification of a new anode material and improved processing of components.

32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

Refer also to citation(s) 23830

23853 (AFME–87-91-0001) **Modal analysis of conductive three-dimensional systems. Utilization of finite elements.** Neveu, A. Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). 1988. 27p. (In French). Order Number DE90761938. Available from NTIS (US Sales Only), PC A03/MF A01.

In order to solve many energetic problems related to the heat conduction in solids, a modal type mathematical model for the multidimension conductive transfer analysis has been developed, using a finite element existing code. The method is applicated to a simple case (a flat plate) and to a more complex case, a diesel engine cylinder head.

23854 (AFME–Z-0096) **Energy conservation.** Anon. Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). 1987. 58p. (In French). (CONF-8704393–: Technical meeting on energy conservation, Moscow (USSR), 13-17 Apr 1987). Order Number DE90761939. Available from NTIS (US Sales Only), PC A04/MF A01.

The various communications presented in this document are concerned mainly with the french technology and experience related to energy conservation. The five main subjects approached are: heat networks and geothermal energy (and especially deep geothermal wells), energy conservation in the transportation sector (mainly the trucks), energy conservation in thermal processes (heat recovery, heat exchangers, mechanical vapour compression) in different energy industries (oil industry, gas industry,...) energy conservation in food industry (drying, ultra-pressing, mechanical vapour compression).

3201 Buildings

Refer also to citation(s) 23414, 23676, 23677, 23678, 25211

23855 (AFME–86-04-0031) **Final report on KREPIS system.** Ferries, B.; Caradant, D.; Moulin, S. Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). 1988. 21p. (In French). Order Number DE90761945. Available from NTIS (US Sales Only), PC A03/MF A01.

KREPIS is a new CAD system in architecture with three components: an architect station and a thermal station cooperating through an information management system. The thermal station supplies evaluation tools and expert systems explaining the result of evaluations and assisting architect with respect to the thermal quality of a project. This report presents specifications of the system with many examples, a technical evaluation of the prototype and some extensions of KREPIS.

23856 (BRE-IP–22/89) **Innovative daylighting systems.** Littlefair, P.J. Building Research Establishment, Watford (UK). Dec 1989. 4p. Order Number DE90761737. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Innovative daylighting systems have two main aims: to improve the distribution of daylight in a space, and to control direct sunlight so that it can be used as an effective working illuminant. This paper outlines the types of system available and gives general guidance to the designer. It will be of interest to architects and engineers. (author).

23857 (CONF-891173–) **Proceedings of the roof wind uplift testing workshop.** Courville, G.E. (comp.); Gillis, P.S. (ed.). Oak Ridge National Lab., TN (USA). Feb 1990. 148p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Roof wind uplift testing workshop; Oak Ridge, TN (USA); 8-9 Nov 1989. Order Number DE90008041. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

On November 8–9, 1989, a group of concerned roofing professionals gathered in Oak Ridge, Tennessee, to exchange information and to hear discussions on topics dealing with wind's effect on roofs. Several important issues were addressed: (1) Wind-related roofing problems are a concern to the roofing industry; (2) There is no comprehensive understanding in the US roofing industry of the dynamics of wind phenomena; (3) There is inadequate field data on wind's effect of roof performance; (4) The correlation between field performance and laboratory testing is poor; (5) Procedures for laboratory testing and field testing are inadequate for many roof systems; (6) There is little roof uplift resistance research underway in the US, and what does exist is poorly coordinated; (7) Manuals, test procedures, standards, and codes for wind uplift are often inadequate, even confusion and contradictory at times; and (8) Building owners are not well enough informed to commit to the cost of wind uplift technology development or even to the design and construction of stronger roofs. These concerns led one group, the Single Ply Roofing Institute (SPRI), to commission a study in 1986 to determine the feasibility of an apparatus for testing whole roof assemblies under conditions that closely simulated real roof wind effects. Results from this study were shared with Oak Ridge National Laboratory (ORNL) which has subsequently submitted a review. A major conclusion from the joint talks with ORNL was the importance of avoiding decisions on an individual uplift testing concept with too narrow a focus on wind-related roofing issues. Subsequently, it was decided to schedule a workshop on the topic with the original sponsors being SPRI, ORNL, and the Naval Civil Engineering Laboratories (NCEL). Each document will have a separate abstract.

23858 (DOE/ER–0448P) **Radon Research Program, FY-1989.** USDOE Office of Energy Research, Washington, DC (USA). Office of Health and Environmental Research. Mar 1990. 202p. Sponsored by U.S. DOE Energy Research. Order Number DE90007916. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

To provide information to interested researchers and the public about its research activities, OHER publishes this annual report. This edition of the report provides information about: the uncertainties involved in estimating radon risks for individuals and the general public, the goals adopted by the Radon Research Program for reducing these uncertainties, the progress that investigators participating in the program have made toward reducing the uncertainties in the past year, and, finally, the program's future direction. 5 figs.

23859 (DOE/HWP–96) **Some statistical sampling considerations for the Navy Radon Assessment and Mitigation Program.** Wright, T. (Oak Ridge National Lab., TN (USA)). Oak Ridge Gaseous Diffusion Plant, TN (USA). Mar 1990. 52p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OT21400. Order Number DE90008851. Available from NTIS, PC A04/MF A01 - OSTI.

This report pulls together several issues, problems, and questions with proposed statistical approaches that helped to guide the planning for the Navy Radon (NAVRAMP) Implementation. Each section is in brief outline form. 6 refs., 27 refs., 11 tabs.

23860 (EPRI-CU–6777) **Packaged terminal heat pump assessment study: Final report.** Pietsch, J.A. (Pietsch (Joseph A.),

Dallas, TX (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Pietsch (Joseph A.), Dallas, TX (USA). c Mar 1990. 84p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A state-of-the-art assessment of packaged terminal heat pumps (PTHPs) is presented. Commercial heating, ventilating and air-conditioning (HVAC) market trends are reviewed as is the position of PTHPs in the commercial market. The features and operating characteristics of PTHPs are examined. A need for improving the low temperature heating performance of PTHPs is identified and concepts are presented for improvements in that area. Finally, research recommendations for enhancing PTHP performance are outlined. 15 refs., 10 figs., 14 tabs.

23861 (LBL–25430) **Control of lamp wall temperature.** Verderber, R.R.; Rubinstein, F.M.; Siminovitch, M.J. Lawrence Berkeley Lab., CA (USA). Jun 1988. 10p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. (CONF-8810312–1: AUTOTESTCON '88: IEEE international automatic testing conference, Minneapolis, MN (USA), 4-6 Oct 1988). Order Number DE90007773. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A review of techniques to control the lamp wall temperature of fluorescent lamps in luminaries is presented. Past results show large increases in efficacy and light output can be obtained (to 25%) if the lamps can be operated at their optimum lamp wall temperature. It may be judicious to review their cost effectiveness in view of the increased energy cost and advances in the devices technology. 15 refs., 2 figs., 1 tab.

23862 (NEI-DK–260) **Energy renovation in Ellebo.** Danmarks Tekniske Hoejskole, Lyngby (Denmark). Fysisk Lab. 3; Gendan A/S, Copenhagen (Denmark). [1989]. 90p. (In Danish). Contract TR-88.1137. Order Number DE90760173. Available from NTIS (US Sales Only), PC A05/MF A01.

In cooporation with Arkitektfirmaet Blad og Thygesen and Ingenioerfirmaet Dominia A/S.

Possibilities for repair of the facades of some blocks of flats (Ellebo) in the town of Ballerup, Denmark, in connection with a total energy renovation of these buildings, are investigated. The potential for electric power conservation and the economical advantages of purchasing a wind turbine are estimated. Suggestions for methods for the handling of household waste, involving sorting at the source, are given. Technical methods of reducing water consumption are presented. It is estimated that these plans can only function if the inmates are involved. (BN).

23863 (NEI-DK–260, pp. 1-31) **Notes on energy renovation in Ellebo.** Danmarks Tekniske Hoejskole, Lyngby (Denmark). Fysisk Lab. 3. [1989]. (In Danish). Contract TR-88.1137. In *Energy renovation in Ellebo.* Order Number DE90760173. Available from NTIS (US Sales Only), PC A05/MF A01.

In cooperation with Arkitektfirmaet Blad og Thygesen and Ingenioerfirmaet Dominia A/S.

Possibilities for repair of the facades of some blocks of flats (Ellebo) in the town of Ballerup, Denmark, in connection with a total energy renovation of these buildings, are investigated. The current heating system, heat and electric power consumption, and the insulation are described. Proposals for renovation, including an estimate of the economy, are presented. (BN).

23864 (NEI-DK–260, pp. 1-31) **Electric power conservation, wind turbines and guidance for the inhabitants in communal residential buildings, Ellebo.** Viegand, J. Danmarks Tekniske Hoejskole, Lyngby (Denmark). Fysisk Lab. 3. [1989]. (In Danish). Contract TR-88.1137. In *Energy renovation in Ellebo.* Order Number DE90760173. Available from NTIS (US Sales Only), PC A05/MF A01.

In cooperation with Arkitektfirmaet Blad og Thygesen and Ingenioerfirmaet Dominia A/S.

Possibilities for electric power conservation in some blocks of flats (Ellebo) in the town of Ballerup, Denmark, are investigated: (1) installation of electric fluorescent lamps on the staircases and time switches in the cellars; (2) replacement of a circulation pump; (3) reconditioning of the washing machines so that hot tap water can be used. It is concluded that wind turbines would be profitable during the first year. It is estimated that these plans can only function if the inmates are involved. Possibilities mentioned are written information, including the establishment of a magazine for the local inhabitants, regular meetings in the evenings, a telephone service in relation to electric power savings, and the creation of a consultative group of residents. (BN) 11 refs.

23865 (NEI-DK–261) **Potentials for conserving electric power in relation to ventilation.** Crone og Koch Raadgivende Ingenioerfirma K/S, Charlottenlund (Denmark). Nov 1987. 27p. (In Danish). Order Number DE90760181. Available from NTIS (US Sales Only), PC A03/MF A01.

Electricity consumption in relation to the ventilation of public-buildings can vary from between 5% and 65% of the total, dependent on the type of ventilation system. In the case of blocks of flats the variation is about 5% where there is a central air extraction unit. For private houses the variation would be 1% as few of these are installed with mechanical ventilation. Possibilities for further reduction of electric power consumption are discussed, and various types of ventilation systems are evaluated with regard to efficiency. The significance of the possibility for regulation of the volume of incoming air is emphasized, and it is pointed out that a considerable number of evaluated systems should be renovated in order that energy consumption should be reduced. D(AB).

23866 (NEI-DK–295) **Development of externally attached extra window frame.** Mogensen, K. Teknologist Inst., Taastrup (Denmark). Afd. for Byggeteknik. Aug 1989. 14p. (In Danish). Contract EM-1213-501-07-01;Contract EM-1213/85-1. Order Number DE90760243. Available from NTIS (US Sales Only), PC A03/MF A01.

EFP-85.

Heat loss and the deterioration of surface treatments of older windows are the most frequent reasons for having to change out completely windows which would otherwise have a long serice life. The aim of the project was to develope a window frame that could be used for attachment to the outside of windows in older buildings. The frame was aluminium and emphasis was also laid on development of suitable hinges. Aesthetic aspects and dimensions were also important. The hinges had to be constructed in such a way that it was possible to pivot the window for cleaning purposes. The purpose of these frames is to reduce expences by contributing to the preservation of existing windows and to conserve energy by utilizing this form of thermal insulation. (AB).

23867 (PB–90-148081/XAB) **Multi-functional garage heater.** Gas Research Inst., Chicago, IL (USA). Oct 1989. 4p. (GRI–89/0292). Available from NTIS, PC A01/MF A01.

The multi-functional garage heater being explored by GRI's Gas Appliance Technology Center would provide general and localized heating. The conceptual appliance features a hose and attachments, a radiant section, effective heat utilization, an isolated combustion chamber, and a remotely programmable thermostat. Schematics are included.

23868 (PNL-SA–17851) **Reassessment of factors influencing lung dose from radon daughters.** James, A.C. Pacific Northwest Lab., Richland, WA (USA). Sep 1989. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. (CONF-8909190–1: Technical exchange meeting on assessing indoor radon health risks, Grand Junction, CO (USA), 18-19 Sep 1989). Order Number DE90008608. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Recent research findings allow for better representation of several biological and physical factors in the modeling of dose to the lung from exposure to radon daughters. New information is available on the efficiency of the nose in filtering unattached radon daughters from inhaled air, the thickness of bronchial epithelium and location of sensitive target cells, the size distribution of unattached daughters and of the fraction of daughters attached to room aerosols, and the variability of these aerosol conditions in actual homes. This information is used here in an updated dosimetry model to reassess the relationship between indoor exposure and bronchial dose, and to evaluate variability with room conditions. 17 refs., 7 figs.

23869 (SBI-R–205) **External insulating sliding shutters.** Andersen, N.E. Statens Byggeforskningsinstitut, Hoersholm (Denmark). 1990. 27p. (In Danish). Contract EM-1213-601-03-01. Available from Available on loan from Risoe Library, DK-4000 Roskilde.

EFP-86.

An insulating window shutter which slides on two rollers above the window outside, and which tightens to the window when shut, has been developed. It can be operated from the inside, if the window opens inward. The shutter construction is very simple and inexpensive. Calculations have shown that a combination of a relatively large window area with night-operated insulating shutters will give an extensive utilization of solar heating and as a result very low heating cost. (author).

23870 (TNO-HMT–88-153) **Low NO_x emissions by radiant burners.** Bartelds, H. Hoofdgroep Maatschappelijke Technologie TNO, Apeldoorn (Netherlands). May 1988. 26p. (In Dutch). Order Number DE90752690. Available from NTIS (US Sales Only), PC A03/MF A01.

The selection of the title subject applicated in central heating installations is described. The state of the art in low NO_x burners is dealt with as well as emission figures, selection of the burners by literature- and patent search or retrieval and the heat transfer from burner to the heated surface. 10 figs., 1 tab., 1 ref.

23871 (TNO-HMT-R–88/080) **Design of a standard reference behavior for energy consumption calculations.** Van der Laan, M.J.; Dubbeld, M.; Van Dongen, J.E.F. Nijverheidsorganisatie TNO, Delft (Netherlands). Hoofdgroep Maatschappelijke Technologie. Mar 1988. 79p. (In Dutch). Order Number DE90752689. Available from NTIS (US Sales Only), PC A05/MF A01.

The title reference behavior has been determined by means of data from an earlier investigation. Starting points are three reference houses and occupants with a low, an average and a high energy consumption. The reference behavior consists of data on the temperature and the temperature control, on ventilation and on the indoor heat load of the houses. For calculations with dynamic computer models extended data are available: for each room the temperature, radiator use, use of windows and ventilation systems and the indoor heat load development as a function of time are given. For manual calculations these data can be brought back to average teperatures, an estimation for the ventilation figures and and the average indoor heat load for each floor and for the total building. 14 figs., 18 tabs., 29 refs., 5 apps.

3202 Transportation

Refer also to citation(s) 25211

23872 (DOE/ET/32043–T31-Vol.2-BK.2) **Final safety analysis report for the Ulysses Mission: Volume 2 (Book 2), Accident model document—Appendices.** General Electric Co., Philadelphia, PA (USA). Astro Space Div. Mar 1990. 673p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC01-79ET32043. (ULS-FSAR–004). Order Number DE90008695. Available from NTIS, PC A99/MF A01 - OSTI.

This section of the Accident Model document presents the appendices which describe the various analyses that have been conducted for use in the Ulysses Final Safety Analysis Report. Included in these appendices are the approaches, techniques, conditions and assumptions used in the development of the analytical models plus the detailed results of the analyses. Also included in these appendices are summaries of the accidents and their associated probabilities and environment models taken from the Shuttle Data Book (NSTS-08116), plus summaries of the several segments of the recent GPHS safety test program. The Appendices contained in this Book are as follows: Accident Definition and Probabilities; Accident Environments; Hydrocode Analysis of RTG Response to Accident Environments; Launch Accident Scenario Evaluation Program (LASEP); JPL Reentry Breakup Analysis; Safety Test Program Summary and Result; Vaporization of PuO_2 in a Space Shuttle Fireball; and RTG/GPHS Reentry Response.

23873 (ESC–51) **Evaluation of energy conservation measures, in the traffic and transportation sector, implemented by the Dutch government during the period 1973-1987.** Kroon, P.; Cornelisse, H. Stichting Energieonderzoek Centrum Nederland, Petten (Netherlands). Energie Studie Centrum. Nov 1989. 184p. (In Dutch). Order Number DE90752614. Available from NTIS (US Sales Only), PC A09/MF A01.

Fourteen energy conservation measures were selected and evaluated grouped under 6 main aspects. A complete description of the measures is provided. The energy conservation related with the 14 measures appears to be 16% of the present consumption of this sector. Total savings in the period 1973-1987 equals present annual consumption. Proof for the energy conservation could not be found in the statistics due to uncertainties and effects of dissaving. Only a saving by personal cars was detectable. The main component of energy savings (50%) results from efficiency improvements by private cars (related with the agreement between car producers and the EC in 1978) and the Dutch legislation with respect to speed limits for road traffic of 1974. Information distribution (fuel efficiency guide) and educational activities concerning economical navigation and driving behavior were responsible for 25% of the energy saving. About 15% of the energy saving is caused by the realized annual vehicle inspection, investment subsidies on energy savings by airplanes, taxation of diesel fuel and energy savings in street lighting. The efficiency of some measures is uncertain because knowledge about the savings potential and the state of penetration is lacking. This may result in a wrong choice of target groups and measures and unjustified expectations about results.

3203 Industrial and Agricultural Processes

Refer also to citation(s) 23375, 23376, 23414, 23429, 23650, 23720, 23860, 23870, 23920, 23973

23874 (AFME–86-11-0159) **Contribution of computers and automation to energy conservation in industry.** Anon. Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). 1986. 149p. (In French). Order Number DE90761942. Available from NTIS (US Sales Only), PC A07/MF A01.

This document presents six papers concerning computers and automation related with energy conservation in industry. Computers are used in every stages of an industrial project: design, optimization, performance analysis and operation on-line optimization, automatic control and maintenance. Examples are given through the study of heat management in industrial processes, real-time energy management in a paper manufacture and in a glass plant, global process optimization program for complex energetic systems and management of a control-command system.

23875 (DOE/CE/40762–T2) **Industrial waste gas assessment.** RCG/Hagler, Bailly, Inc., Washington, DC (USA). 31 Jan 1990. 138p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC01-87CE40762. Order Number DE90007567. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

RCG/HBI Reference No. 89-5080.

To improve industrial energy efficiency and promote pollution reduction efforts, the Office of Industrial Programs of the US Department of Energy supports R & D in the area of waste gas utilization and minimization. In this report, RCG/Hagler, Bailly, presents its assessment of five selected waste gases – toluene, xylene, ammonia, methanol, and methane, focusing on their production, end-uses, and emissions; market factors affecting emissions; and current potential R & D efforts.

23876 (DOE/ID–10269) **Assessment of sensors used in the food industry: Final report.** Pedersen, L.D.; Rose, W.W.; Redsun, H.; Boghosian, S.H. National Food Processors Association, Dublin, CA (USA). Jan 1990. 188p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC07-76ID01570. Order Number DE90008846. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

The growth of automation within the food processing industry has led to heavy reliance on sensor measurement of process variables such as temperature, pressure, flow, viscosity, color, and moisture. While well-developed sensor technology and properly

functioning sensors can facilitate efficient and cost-competitive processes, it is clear that malfunctioning or inadequate sensors can cause significant waste of food product, packaging materials, labor, capital investment, time, and energy. Of all the production resources listed above, energy is the major resource of concern for this study. While energy efficiency in general has been a focus of the food industry in the recent past, and while the industry has improved energy use significantly, there remains a specific need to improve detection and measuring devices as a means to further gains. Sensors and sensor technology within the food processing industry are therefore the focus of the work reported here. The ultimate goal of this endeavor is to promote an energy efficient and cost competitive food industry by facilitating improvements in sensors and sensor technology. 138 refs., 10 figs., 7 tabs.

23877 (EGG-M–89483) **Fruit ripeness detection by using H^1 NMR [Nuclear Magnetic Resonance].** Cho, Seong In (Purdue Univ., Lafayette, IN (USA). Dept. of Agricultural Engineering); Krutz, G.W. EG and G Idaho, Inc., Idaho Falls, ID (USA); Purdue Univ., Lafayette, IN (USA). Dept. of Agricultural Engineering. [1989]. 11p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC07-76ID01570;FC07-89ID12917. (CONF-891280–1: 1989 ASAE winter meeting, New Orleans, LA (USA), 11 Dec 1989). Order Number DE90007042. Available from NTIS, PC A03/MF A01; OSTI; INIS.

The possibility of detecting ripeness of raw fruit by measuring sugar content with an A-200 Fourier Transform (FT) Nuclear Magnetic Resonance (NMR) was investigated. Then, the samples of sugar-water mixtures and real fruit were tested with the NMR and the correlations of sugar contents to NMR spectra were obtained. Sugar content (or ripeness level) was linearly correlated to the intensity of sugar peaks in the NMR spectra. This result make it possible to grade raw fruit non-destructively. 10 refs., 11 figs., 3 tabs.

23878 (EPRI-CU–6755) **Food industry scoping study: Final report.** Electric Power Research Inst., Palo Alto, CA (USA); Resource Dynamics Corp., Vienna, VA (USA). c Mar 1990. 241p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This Scoping Study provides an analysis of market and economic forces affecting food industry manufacturing processes, and the current and potential role of electrotechnologies in improving productivity and competitiveness. The research and development activities of food trade associations and research institutions are examined. EPRI-sponsored activities and utility programs affecting food industry customers are reviewed. These analyses indicate that significant opportunities exist for the application of various electrotechnologies in most food processing sectors. Due to the processing methods, energy use characteristics and industry growth trends, the dairy, fruit and vegetables, grain and beverage processing sectors present the most promising applications. However, not all of this potential is being effectively tapped. utilities need better-defined programs to help their food industry customers identify efficient energy utilization options and technologies. The appropriate use of electrotechnologies could help improve food industry productivity, processing efficiency and product quality. This Scoping Study recommends the establishment of an EPRI food electrotechnology office. The office will work with affiliated organizations in major food processing regions to design education and technical support, R & D and technology transfer programs for EPRI-member utilities. 24 figs., 23 tabs.

23879 (EPRI-CU–6775) **Pinch technology: A primer: Final report.** Karp, A. (Linnhoff March, Inc., Leesburg, VA (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Linnhoff March, Inc., Leesburg, VA (USA). c Mar 1990. 220p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Pinch Technology is a technique for analyzing and optimizing total energy systems. Industrial sites use energy in many forms and in many inter-related ways. Conventional design practices generally seek to optimize these energy uses individually. However, radically different – and far superior – systems can be achieved by using Pinch Technology to identify optimal designs and operating practices. This guide explains what Pinch Technology is and how it may be beneficially utilized by electric utilities and their industrial customers. The book is segmented in 3 stand-alone sections ("Pinch Technology in Perspective," "Pinch Technology in Practice," and "Pinch Technology Theory") that tailor the discussion to different utility and industrial audiences, both technical and nontechnical. 68 refs., 114 figs., 5 tabs.

23880 (NEI-DK–264, pp. 259-274) **Computerized management of industrial solid waste: The case of the city of Copenhagen. .** Vidal, R.V.V. (The Institute of Mathematical Statistics and Operations Research, The Technical University of Denmark, Lyngby (DK)); Nielsen, C.S.; Svensson, L. Technical Univ. of Denmark, Lyngby (Denmark). Inst. of Mathematical and Operations Research. 1989. (CONF-8809459–: Conference on the systems analysis approach to environmental and natural resources management in the Baltic region, Gdansk (Poland), 26-29 Sep 1988). In *Proceedings of the conference on the systems analysis approach to environmental and natural resources management in the Baltic region.* Order Number DE90760200. Available from NTIS (US Sales Only), PC A13/MF A01.

This introduction will give a short presentation of a project concerning the development of an information system for control and supervision of industrial solid wastes. The background for the project is the increasing need to restrict the amount of wastes and the strain on the environment resulting from the growing amount of wastes. In the legislation, requirements are made for the municipalities to register and recover wastes, including hazardous wastes. The strategies of The Local Office of Environmental Protection, The City of Copenhagen in relation to a regulation of industrial wastes will be outlined briefly, especially as regards the possibilities of recyling the industrial wastes (with a view to manufacturing high-quality products), combustibility (with a view to replacing other sources of energy), and detection of hazardous wastes. It has been found that the analysis of sources, registration and classification of the industrial wastes will be central tasks. The physical (logistic) system is rather complex, as it includes both production, distribution and disposal of the wastes and is at the same time under continous change. A computer-based information system is therefore in the developing process. Such a system is being designed especially for solving of the problems of the Local Office of Environmental Protection, The City of Copenhagen in connection with control and decision related to industrial solid wastes. The information system should be flexible, user-friendly and be capable of being implemented in a PC-environment. (author).

23881 (NEI-DK–264, pp. 275-283) **Information system supporting assessment of waste problem in Gdansk voivodship.** Cala, C. (Instytute of Geography and Spatial Organization, Polish Academy of Sciences (PL)); Krajewski, W.; Krus, L.; Malicka-Wasowska, J.; rokicki, W. Technical Univ. of Denmark, Lyngby (Denmark). Inst. of Mathematical and Operations Research. 1989. (CONF-8809459–: Conference on the systems analysis approach to environmental and natural resources management in the Baltic region, Gdansk (Poland), 26-29 Sep 1988). In *Proceedings of the conference on the systems analysis approach to environmental and natural resources management in the Baltic region.* Order Number DE90760200. Available from NTIS (US Sales Only), PC A13/MF A01.

An information system is proposed which can provide a proper information for the environmental impact assessment of alternative technologies. The system utilizes a mathematical model, data base and expert methods. The mathematical model describes production and consumption processes in a form of technological chains and dendrits taking into account sources, recycling and utilisation of wastes. The system is being developed in the case of Gdansk voivodship in Poland. (author).

23882 (NEI-DK–294) **Utilization of cogenerated power and heat in market gardens: Summary of partial projects carried out in the period 1986-89.** Energiministeriets Energiforskningsprogram. Fjernvarme og produktion af el og varme. Samfundsteknik A/S, Odense (Denmark); S.A.A.S. Instruments A/S, Roedovre (Denmark); Cowiconsult Raadgivende Ingenioerer A/S, Virum (Denmark); Hoejlund Rasmussen (B.) Raadgivende Civilingenioerer, Copenhagen (Denmark). Dec 1989. 49p. (In Danish).

Contract EM-1233/87-1. Order Number DE90760242. Available from NTIS (US Sales Only), PC A03/MF A01.

EFP-87.

A survey of greenhouse conditions, in relation to energy supplies from district heating plants utilizing cogeneration, based on a number of previous reports. The aim was to investigate specific problems and observe the efficiency of plant growth, especially with regard to quality and economic aspects. Environmental effects and the potential for energy conservation were also studied. (AB).

23883 (PB–90-857392/XAB) **Pulping: Energy consumption and conservation. January 1976-May 1985 (Citations from the Paper and Board, Printing, and Packaging Industries Research Associations data base). Report for January 1976-May 1985.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 126p. Available from NTISPC N01/MF N01.

See also PB–90-857400.

This bibliography contains citations concerning energy saving processes, machinery and plants applicable to the pulping industry. Water removal and wet pressing, small power steam and electricity generation, mathematical modelling for determining energy consumption, mechanical pulping energy reduction techniques, fiber pretreatment, cooking methods and equipment, and heat recovery processes are among the topics included. Energy efficient pulp mill operation management is included. (This updated bibliography contains 163 citations, none of which are new entries to the previous edition.)

23884 (PB–90-857400/XAB) **Pulping: Energy consumption and conservation. June 1985-December 1989 (Citations from the Paper and Board, Printing, and Packaging Industries Research Associations data base). Report for June 1985-December 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 93p. Available from NTISPC N01/MF N01.

Supersedes PB–85-861151. See also PB–90-857392.

This bibliography contains citations concerning energy saving processes, machinery, and plants applicable to the pulping industry. Water removal and wet pressing, small power steam and electricity generation, mathematical modelling for determining energy consumption, mechanical pulping energy reduction techniques, fiber pretreatment, cooking methods and equipment, and heat recovery processes are among the topics included. Energy efficient pulp mill operation management is included. (This updated bibliography contains 118 citations, all of which are new entries to the previous edition.)

23885 (PB–90-858168/XAB) **Waste heat utilization. January 1971-January 1990 (Citations from the US Patent data base). Report for January 1971-January 1990.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 146p. Available from NTISPC N01/MF N01.

Supersedes PB–85-867489.

This bibliography contains citations of selected patents concerning processes employed for the recovery of useful heat from the environment, or from equipment which generates waste heat. Heat pump systems, furnaces, industrial boilers, and systems employed in the recovery of heat from internal combustion engines are discussed. (This updated bibliography contains 307 citations, 106 of which are new entries to the previous edition.)

23886 (UCRL–21264) **Statistical equipment modeling for VLSI manufacturing.** Lin, K.K. (California Univ., Berkeley, CA (USA)); Huang, J.; Spanos, C. Lawrence Livermore National Lab., CA (USA). Oct 1989. 2p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8910107–10: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989). Order Number DE90008527. Available from NTIS, PC A02/MF A01 - OSTI.

The systematic methodology presented here aims at building and calibrating equipment-specific process models. These models describe the nominal equipment response and also the inherent process variations. D-Optimal experiment design, combined with statistical modeling, is employed for the characterization and representation of the equipment and its associated processes. The methodology has been successfully applied for modeling a furnace used for low pressure chemical vapor deposition (LPCVD) of undoped polysilicon. A 2-stage D-Optimal design with 24 experiments was used to refine and calibrate physically-derived LPCVD models for the specific furnace. Statistical models have been built for two equipment responses, namely the polysilicon deposition rate and the built-in wafer stress. These models agree well with the experiment data, and account correctly for the observed variations. 7 refs., 6 figs.

3206 Municipalities and Community Systems

Refer also to citation(s) 23415, 23650, 23816

23887 (BNL–43844) **Ice-making heat exchanger evaluation and test plan.** Andrews, J.W.; Leigh, R.W.; Piraino, M.W. Brookhaven National Lab., Upton, NY (USA). Jan 1990. 17p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-76CH00016. Order Number DE90008824. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Several approaches to making ice for district cooling are identified and their current status discussed. Recommendations for future work are given, with a detailed plan for one phase of the work. 13 refs., 5 figs.

23888 (CONF-900496–1) **Dioxin emissions from municipal solid waste incinerators and the potential for human exposure.** Hattemer-Frey, H.A.; Travis, C.C. Oak Ridge National Lab., TN (USA). [1990]. 35p. Sponsored by Environmental Protection Agency. DOE Contract AC05-84OR21400. From Symposium on municipal solid waste management: making decisions in the face of uncertainty; Toronto (Canada); 25-27 Apr 1990. Order Number DE90008901. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Although sanitary landfills are currently the primary method of municipal solid waste (MSW) management, the US Environmental Protection Agency estimates that half of all municipalities will lack adequate landfill space within 10 years. Numerous cities and counties are considering MSW incineration as an alternative waste management option. Because combustion is widely recognized as a source of polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs), including the highly toxic 2,3,7,8,-tetrachlorodibenzo-p-dioxin, considerable local and national opposition to MSW incineration has arisen. Many people living near MSW incinerators fear that they will be exposed to high levels of PCDDs and PCDFs and subsequently develop cancer. As the controversy surrounding MSW incineration intensifies, government agencies, public officials, and the public question whether municipal waste combustion is a feasible waste management alternative. Given the sensitivity and importance of this issue, however, we have attempted such an evaluation. This paper is intended to examine the following issues concerning human exposure to facility-emitted dioxins and furans: (1) Are environmental concentrations of PCDDs and PCDFs around MSW incinerators elevated? (2) Are MSW incinerators the major source of human exposure to PCDDs and PCDFs? and (3) Are incinerators the major source of PCDD/PCDF input into the environment? 67 refs., 6 tabs.

23889 (LBL–27872) **Controlling summer heat islands: Proceedings.** Garbesi, K.; Akbari, H.; Martien, P. (eds.). Lawrence Berkeley Lab., CA (USA). Nov 1989. 351p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. (CONF-8902142–: Workshop on saving energy and reducing atmospheric pollution by controlling summer heat islands, Berkeley, CA (USA), 23-24 Feb 1989). Order Number DE90008075. Available from NTIS, PC A16/MF A01 - OSTI; GPO Dep.

A workshop was held on the energy and pollution implications of summertime urban heat islands and the potential to control them. The presentations, papers, and discussions fell into four broad categories: (1) the potential to conserve energy, reduce atmospheric pollution, and slow global warming by reducing summer heat islands; (2) the use of computer models to understand and simulate the heat island phenomenon; (3) measurements of heat islands; and (4) the design and implementation of heat island mitigation strategies. On the afternoon of the second day of the workshop,

the participants divided into three workgroups. Group 1 discussed research needs to better quantify the effect of heat island mitigation on energy use. Group 2 discussed future research on the characterization and modeling of heat islands. And Group 3 discussed the development of a manual that would present to policy makers our current knowledge of techniques to mitigate heat islands and thereby save energy. This Proceedings documents the presentations and outcome of the Workshop.

23890 (NEI-DK–288) **Pilot study of smaller gas turbines.** Astrupgaard, N.P. (dk-TEKNIK (Denmark)); Weel Hansen, M. Nordisk Gasteknisk Center, Hoersholm (Denmark). Oct 1989. 64p. (In Danish). Order Number DE90760251. Available from NTIS (US Sales Only), PC A04/MF A01.

In the present pre-project the possibilities for application of serially produced turbo-chargers as gasturbines within the range of approx. 50-500 kW electrical output have been examined. Preliminary studies and calculations showed that the range about 250 kW electrical output would be the lower economical limit. The pre-project was consequently concentrated on plants of 250 kWe and more. A 250 kWe unit is proposed to be designed with two turbochargers, a combustion chamber, power-turbine, and an intermediate cooler. With this design an electricity efficiency of approx. 16-18% is achieved. According to our estimate, a mini-gasturbine based on turbochargers with an output of approx. 250 kW can be manufactured for a good 1 million DKK, or 4,000 DKK/kW, i.e. within the frames of the economic aim of 3,500-4,500 DKK/kW. Application of the mini-gasturbine might first and foremost be interesting in connection with heat deliveries or drying based on steam. Furthermore, the mini-gasturbine may form part of a special power burner unit in existing district heating boilers. The market potential for the applications mentioned here are evaluated - alone in the Nordic countries - to make out at least 250 MW, corresponding to 1000 units. (author).

3209 Education and Public Relations

Refer also to citation(s) 23871

33 ADVANCED PROPULSION SYSTEMS

3301 Internal Combustion Engines

Refer also to citation(s) 23424, 23427, 23448

23891 (PB–90-858192/XAB) **Internal combustion engine fuel controls. December 1970-December 1989 (Citations from the US Patent data base). Report for December 1970-December 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 148p. Available from NTISPC N01/MF N01.

Supersedes PB–85-861839.

This bibliography contains citations of selected patents concerning fuel control devices, and methods used to regulate speed and load in internal combustion engines. Techniques utilized to control air-fuel ratios by sensing pressure, temperature, and exhaust composition, and the employment of electronic and feedback devices are discussed. Methods used for engine protection and optimum fuel conservation are considered. (This updated bibliography contains 327 citations, 160 of which are new entries to the previous edition.)

23892 (TNO-IWTE–03) **Methanol in diesel engines with increased efficiency by means of methanol dissociation.** Ter Rele, R.R.J.; Van Asch, R.; Van der Does, C. Instituut voor Wegtransportmiddelen TNO, Delft (Netherlands). Jun 1988. 60p. (In Dutch). Project TNO-IW 700330123;Project PEO 91210.150. Order Number DE90752691. Available from NTIS (US Sales Only), PC A04/MF A01.

The methanol dissociation project had the purpose to demonstrate a system in a diesel engine in which a part of the diesel fuel is replaced by dissociated methanol. The demonstration has been executed in a DAF 615 diesel engine under pressure. A previous developed diesel mixing operating system provided for correct gas quantity for all the load conditions. The Dutch State Mines (DSM) did research on the most appropriate catalyst and designed a methanol dissociation reactor. Descriptions of the fuel system, methanol evaporator and methanol dissociation reactor are given. Results of several measurements are presented: measurements on the diesel motor as a standard design, measurements for evaporated methanol as a substitute fuel for diesel and measurements for dissociated methanol or synthetic dissociation gas as substitute fuels. Differences between diesel and the substitutes are discussed. 12 figs., 4 ills., 3 tabs., 10 apps.

3303 Electric-Powered Systems

Refer also to citation(s) 23893

3307 Emission Control

Refer also to citation(s) 23330

3308 Alternative Fuels

Refer also to citation(s) 23451, 23892

23893 (ESC–52) **Impacts of environmental and oil-price constraints on alternative automotive fuels and vehicles.** Kram, T.; Okken, P.A. Stichting Energieonderzoek Centrum Nederland, Petten (Netherlands). Energie Studie Centrum. Nov 1989. 90p. (In Dutch). Order Number DE90752613. Available from NTIS (US Sales Only), PC A05/MF A01.

The Energy Study Centre of Netherlands Energy Research Foundation has designed a set of energy scenarios to evaluate the role of emerging energy technologies and fuels up to the year 2020 in order to support energy R and D policy. The possible future penetration of a few hundred different energy technologies and fuels, including alternative automotive fuels, are assessed in this study. Scenario calculations are made with the IEA-MARKAL model. This process-oriented national-cost-minimizing dynamic LP-model can be used to test future energy technologies for R and D policy purposes. Current use of automotive fuels in Western Europe is almost exclusively based on oil. Long term oil supplies being uncertain, a considerable research effort in Europe is devoted to alternative non-oil automotive fuels and vehicle development. Yet substantial oil substitution is not foreseen in the near future. In general research-scientists tend to introduce an optimistic view in their cost estimates and market assessments. Optimistic European estimates of alternative fuels market introduction, vehicle costs and vehicle performance have been carefully evaluated (and adjusted if necessary) before use in this study. Calculations with alternative non-oil fuels and vehicles are reported for two mobility scenarios. Sensitivity analyses are made reflecting different environmental (NO_x, CO_2) and oil-price constraints. Methanol and electric city vehicles appear to be attractive alternatives under most constraints. In some cases biofuels (ethanol, vegetable oils), stirling engines and compressed natural gas also seem to be attractive.

23894 (NYSERDA–90-2) **Safety analysis of natural gas vehicles transiting highway tunnel: Final report.** Shaaban, S.H.; Zuzovsky, M.; Anigstein, R. Ebasco Services, Inc., New York, NY (USA). [1989]. 183p. Sponsored by New York State Energy Research and Development Authority. Available from OSTI; New York State Energy Research and Development Authority, Two Rockefeller Plaza, Albany, NY 12223-9998.

A safety analysis was performed to assess the relative hazard of compressed natural gas (CNG) fueled vehicles traveling on various tunnels and bridges in New York City. The study considered those hazards arising from the release of fuel from CNG vehicles ranging in size from a passenger sedan to a full size 53 passenger bus. The approach used was to compare the fuel hazard of CNG vehicles to the fuel hazard of gasoline vehicles. The risk was assessed by estimating the frequency of occurrence and the severity of the hazard. The methodology was a combination of analyzing accident data, performing a diffusion analysis of the gas released in the tunnel and determining the consequences of ignition. Diffusion analysis was performed using the TEMPEST code for various accident scenarios resulting in CNG release inside the Holland Tunnel.

The study concluded that the overall hazard of CNG vehicles transiting a ventilated tunnel is less than the hazard from a comparable gasoline fueled vehicle. 134 refs., 23 figs., 24 tabs.

23895 (OU/ME–CE02910) **Thermodynamic model predictions to reduce combustion pressure rates of low cetane fuels in high-speed diesel engine.** Flanagan, R.C.; Xia, Y.Q. Ottawa Univ., ON (Canada). Dept. of Mechanical Engineering. Aug 1987. 7p. (CONF-8708356–: International Energy Agency Task Leaders workshop, Ottawa (Canada), Aug 1987; CE–02910). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

A thermodynamic and combustion model was developed for a twostroke, turbocharged, compression ignition engine. The model was fit to the AVGP-GM6V53T engine through direct correlation with experimental data. Engine/fuel interaction studies provided considerable insight into the behavior, combustion and ignition delay of the off-specification fuels. A number of parametric studies were conducted and focused on both engine performance and combustion parameters, in particular: indicated power, thermal efficiency, maximum cylinder pressures and maximum cylinder pressure rates. Intercooling was seen as the single most promising parameter for improving engine performance and could be coupled with increased mass of fuel injected. Also, of the standard engine variables, injection timing was seen to be the most attractive approach for controlling the high pressure rates associated with the low-cetane fuels, however, losses in thermal efficiency also result. On the other hand, it was predicted that an optimized dual injection (pilot plus main) could reduce the pressure rates without any appreciable loss in engine thermal efficiency or rated engine power. The modeling approach used is reviewed, in particular the simulation of early or onset of combustion. 6 refs., 1 tab., 7 figs.

35 ARMS CONTROL

Refer also to citation(s) 24342

3501 Policy, Negotiations, and Legislation

23896 (AD-A–215576/0/XAB) **Intermediate-range Nuclear Forces (INF) negotiations and treaty: An historical case study. Master's thesis.** Wussler, D.E. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Systems and Logistics. Sep 1989. 122p. (AFIT/GSM/LSM–89S-46). Available from NTIS, PC A06/MF A01.

This thesis performs detailed analysis of the Intermediate Range Nuclear Forces (INF) negotiations and treaty and compares them with those of the two Strategic Arms Limitations Talks (SALT). The study's objectives were: describe SALT and INF negotiations and the contents of the treaties; analyze US and Soviet goals and strategies during the INF negotiations; determine which goals were or were not attained by both sides, and ascertain reasons for this; and delineate arms control progress and prospects since INF Treaty ratification. The study found that the two SALT treaties did impose ceilings in certain areas of strategic weapons but did not curtail the arms race. Treaty verification methods were criticized as being lax. The US achieved the major goal of ridding Europe of the Soviet SS-20 missile. It had to deploy missiles of its own to make the USSR realize the seriousness of its resolve. The US had total support from NATO in achieving this goal. However, with INF gone, the European conventional forces imbalance looms larger, and the West is fighting to obtain asymmetric conventional cuts.

23897 (AD-A–215606/5/XAB) **First-strike stability: A methodology for evaluating strategic forces. Interim report.** Kent, G.A.; Thaler, D.E. Rand Corp., Santa Monica, CA (USA). Aug 1989. 90p. (RAND/R–3765-AF). Available from NTIS, PC A05/MF A01.

This report presents a logical and transparent methodology for evaluating strategic offensive forces on the basis of first-strike stability, which the authors define as a condition that exists when neither superpower perceives the other as motivated by the strategic force posture to launch the first nuclear strike in a crisis. The methodology underlines that (1) first-strike stability under current conditions is relatively robust, (2) postures of U.S. and Soviet strategic nuclear forces become increasingly important under an arms reduction regime if the current level of first-strike stability is desired, (3) enlarging U.S. and Soviet strategic nuclear weapons inventories does not necessarily erode first-strike stability, (4) the superpowers should realize the importance of both sides generating forces early in a crisis to render these forces nontargetable.

3503 Verification

23898 (UCRL–101686) **Yield threshold decision framework.** Judd, B.R.; Younker, L.W.; Hannon, W.J. Lawrence Livermore National Lab., CA (USA). 17 Aug 1989. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-8908141–4: U.S. Department of Energy conference on technology research and development for arms control verification, Los Alamos, NM (USA), 29-31 Aug 1989). Order Number DE90008720. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The USA is developing a decision analysis framework for evaluating the relative value of lower yield thresholds and related verification policies. The framework facilitates systematic analysis of the major issues in the yield threshold decision. The framework can be used to evaluate options proposed either in the interagency process or in the negotiations. In addition, the framework can measure the importance of uncertainties and alternative judgments, and thereby determine the advantages of additional research. Since the model is explicit and quantitative, it provides a rational, defensible approach for reaching important treaty and verification decisions. 9 figs.

36 MATERIALS

Refer also to citation(s) 23831, 24010, 24021, 24022

23899 **Crystal structures of $NaCuO_2$ and $KCuO_2$ by neutron diffraction.** Brese, N.E. (Arizona State Univ., Tempe (USA)); O'Keeffe, M.; Young, V.G. Jr.; Von Dreele, R.B. *Journal of Solid State Chemistry (USA)*, 83(1): 1-7 (Nov 1989).

The structures of $NaCuO_2$ and $KCuO_2$ have been refined from time-of-flight neutron data. $NaCuO_2$ is monoclinic: space group C2/m, a = 6.3512(2) Å, b = 2.7474(1) Å, c = 6.1027(2) Å, β = 120.767(2)° with Cu-O = 1.839(1) Å (4x). $KCuO_2$ is orthorhombic: space group Cmcm, a = 4.3742(1) Å, b = 11.6859(4) Å, c = 5.4124(2) Å with Cu-O = 1.826(3) Å (2x) and 1.832(2) Å (2x). Both structures contain strings of edge-sharing CuO_4 rectangles. The sodium atoms center octahedra and the potassium atoms center trigonal prisms. Aspects of the crystal chemistry of both compounds are discussed.

23900 **Characteristics of hydrogenated amorphous silicon-germanium alloys.** Luft, W. (Solar Energy Research Institute, Golden, CO (USA)). *Applied Physics Communications (USA)*, 9(1-2): 43-63 (Mar-Jun 1989). DOE Contract AC02-83CH10093.

Data in the literature are summarized for hydrogenated amorphous silicon-germanium (a-SiGe:H and a-SiGe:H:F) alloys that show the relation between germanium content, hydrogen content, deposition methods, feed-gas mixture, and other deposition parameters, and properties such as the optical band gap, dark and photoconductivities, photosensitivity, Urbach parameter, and spin density. Examining RF glow discharge with both a diode and a triode geometry, DC proximity glow discharge, and photochemical vapor deposition (photo-CVD), using various hydrogen-diluted and undiluted gas mixtures, one observes that hydrogen (or inert gas) dilution is essential for obtaining high photosensitivity in SiGe alloys (in contradistinction to a-Si:H). Hydrogen dilution results in about an order of magnitude higher photosensitivity in a-SiGe:H than do undiluted gas mixtures. Aside from hydrogen dilution, neither the gas mixture nor the deposition method (various glow discharges or photo-CVD) appears to affect the photosensitivity of SiGe alloy films with optical band gaps of approximately 1.5 eV.

23901 Jonker-type analysis of small polaron conductors. Nell, J. (Northwestern Univ., Evanston, IL (USA)); Wood, B.J.; Mason, T.O.; Dorris, S.E. *Journal of Solid State Chemistry (USA)*, 82(2): 247-254 (Oct 1989). DOE Contract FG02-84ER45097.

Plots of Seebeck coefficient vs. the logarithm of electrical conductivity (Jonker plots) can be used to discriminate small polaron from band-type semiconductivity. Furthermore n-type and p-type small polaron conduction can be discriminated. Examples are drawn from systems exhibiting extensive nonstoichiometry, e.g., CeO_{2-x} and $Fe_{1-x}O$, systems involving extensive doping, e.g., $LaCrO_3$:Sr and Mn_3O_4:Fe, and systems with extensive solid solubility, e.g., the spinel ferrites. Capabilities and limitations of the analysis are discussed.

23902 The electronic and vibronic transitions in the emission spectrum of Gd^{3+} in the yttrium hydroxide structure. Blasse, G. (Univ. of Utrecht (Netherlands)); Brixner, L.H.; Mroczkowski, S. *Journal of Solid State Chemistry (USA)*, 82(2): 303-306 (Oct 1989).

It has been shown that the emission of the Gd^{3+} ion can be successfully studied using X-ray excitation. Higher level emissions and vibronic transitions were also observed. In this study the authors tried to observe cooperative vibronic transitions involving the Gd^{3+} ion and the hydroxyl group. Well-defined single crystalline needles of several millimeters in length were obtained hydrothermally at 400 C and 15,000 atm in Ag tubes. Their X-ray patterns were in excellent agreement with ASTM File Card No. 24,1422. Measurements were performed at 300 K. The intensity of the OH^- vibronic transition in the emission spectrum of the Gd^{3+} ion has an unexpectedly low value.

23903 Electronic shift register memory based on molecular electron-transfer reactions. Hopfield, J.J. (California Institute of Technology, Pasadena (USA)); Beratan, D.N.; Onuchic, J.N. *Journal of Physical Chemistry (USA)*, 93(17): 6350-6357 (24 Aug 1989).

The design of a shift register memory at the molecular level is described in detail. The memory elements are based on a chain of electron-transfer molecules incorporated on a very large scale integrated (VLSI) substrate, and the information is shifted by photoinduced electron-transfer reactions. The design requirements for such a system are discussed, and several realistic strategies for synthesizing these systems are presented. The immediate advantage of such a hybrid molecular/VLSI device would arise from the possible information storage density. The prospect of considerable savings of energy per bit processed also exists. This molecular shift register memory element design solves the conceptual problems associated with integrating molecular size components with larger (micron) size features on a chip.

23904 Photochemistry on surfaces. 3. Spectral and photophysical properties of monomeric and dimeric anthracenesulfonates adsorbed to colloidal alumina-coated silica particles. Ford, W.E. (Univ. of Notre Dame, IN (USA)); Kamat, P.V. *Journal of Physical Chemistry (USA)*, 93(17): 6423-6428 (24 Aug 1989).

Anthracene-2 sulfonate (2AS) molecules dimerized upon adsorption from aqueous solution onto positively charged alumina-coated silica particles (25-nm diameter). This ground-state dimerization was accompanied by an intensification and red-shift (from 370 to 401 nm) of the O-O absorption band and a large decrease in fluorescence quantum yield. Anthracene-1,5-disulfonate (1,5AS) and anthracene-1-sulfonate molecules also adsorbed to the particles but did not dimerize. Triplet states of the adsorbed molecules were characterized by laser flash photolysis. Direct photoexcitation of the 2AS dimer failed to produce an observable triplet state, but photosensitization yielded a triplet state of the dimer resembling that of the monomer. The triplet state of the adsorbed 1,5AS molecule was obtained by either direct or sensitized excitation. Binding capacities of the particles for 2AS and 1,5AS indicated that at maximal coverage the 2AS molecules were tilted with respect to the surface while the 1,5AS molecules were coplanar. Dimerization of 2AS occurred even when fewer than 1% of available adsorption sites were occupied.

23905 Photochemistry on surfaces. 4. Influence of support material on the photochemistry of an adsorbed dye. Gopidas, K.R. (Notre Dame Radiation Lab., IN (USA)); Kamat, P.V. *Journal of Physical Chemistry (USA)*, 93(17): 6428-6433 (24 Aug 1989).

The absorption and emission properties of rose bengal have been characterized on the surfaces of SiO_2, Al_2O_3, and TiO_2 particles. The intrinsic properties of these oxide supports play an important role in effecting and controlling the photochemistry of the adsorbed dye. On the Al_2O surface, a biphotonic photoionization process leads to the production of semioxidized dye. However, a charge injection from the excited dye into the conduction band dominates on the TiO_2 particles. Steady-state photolysis indicates a rapid photodegradation of the dye only on the surface of TiO_2. The diffuse reflectance laser flash photolysis experiments which elucidate the mechanism of photochemical processes on these oxide supports are described.

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Refer also to citation(s) 23412, 23413, 23511, 23605, 23725, 23728, 23752, 23770, 23777, 23784, 23899, 23901, 23902, 23959, 23967, 24021, 24022, 24042, 24060, 24061, 24071, 24074, 24075, 24154, 24156, 24190, 25076, 25077, 25084, 25183, 25184, 25185, 25193

23906 (AD-A-215125/6/XAB) **Microanalysis of atomic clustering in electromagnetic materials. Final report, 1 October 1981-30 September 1982.** Tebble, R.S. Salford Univ. (UK). Dept. of Pure and Applied Physics. 30 Sep 1982. 11p. Available from NTIS, PC A03/MF A01.

Possible clustering mechanism have been studies in two systems (i) intermetallic spin glass compound Co (x) Ga (1-x) and (ii) amorphous magnetic ribbons of general composition (fe,Co) (1-x) (B,Si)(x). In the CoGa system evidence for vacancy clustering has been found following bombardment by Ar(+) ions, this gives rise to dislocation dipoles up to 0.5 microns in length. Annealing or magnetic annealing of the amorphous ribbons may produce ordering of interstitial boron, phosphorus or silicon atoms or clustering of separate amorphous phases: in either case uniaxial anisotropy is liked to be induced. Ion, proton and electron irradiation of amorphous materials can produce similar effects. Annealing above the crystallization temperature results in precipitation of second crystalline phases.

23907 (AD-A-215246/0/XAB) **Superconducting thin films, composites, and junctions. Final report, 1 October 1983-31 March 1984.** Geballe, T.H. Stanford Univ., CA (USA). Dept. of Applied Physics. Apr 1984. 8p. Available from NTIS, PC A02/MF A01.

The first specific heat measurements on artificially layered superconducting composite structures have been made. Small sample calorimetry has been used to measure the specific heat of NbZr multilayers with a bi-layer period varying from 32 A to 429 A (to a sample thickness of 1.5 um) over the temperature range from 1.5 to 20. The normal state parameters agree with the presence of an interface of an niobium zirconium alloy in agreement with earlier X-ray results. The behavior of the thermally measured transition into the superconducting state and the magnitude of the associated specific heat increase also agree with the Tri-layer model.

23908 (AD-A-215334/4/XAB) **Superconducting thin films, composites, and junctions. Final report, 1 October 1983-30 September 1984.** Geballe, T.H. Stanford Univ., CA (USA). Edward L. Ginzton Lab. 30 Oct 1984. 18p. (GL-3783). Available from NTIS, PC A03/MF A01.

The Nb-Al system has been used as a model system to study the phase transformation in metastable alloys by using the superconductivity of the A15 phase to determine the composition with the highest Tc, and the lattice constant to determine the average composition. By depositing Nb-Al in a phase spread orientation onto substrates at C, the bcc structure has been extended to about 40 at % (well above the equilibrium 9%). Subsequent annealing experiments transformed the bcc phase to A15. It was found that stochiometric Nb3Al could be formed in the A15 phase well above the concentration of the Al at equilibrium which is 22%, when the slopes of the free energy curves of the respective phases are

equal. Thus the particular shape of the (free) energy curves is important and can determine the composition of the precipitated phase. Nb-Sn-Ga alloys were prepared and studied as model systems to investigate the influence of third element additions on the normal and superconducting properties of alloyed Nb-3Sn phases. In spite of a decrease in the density of states at the Fermi level with increasing Ga content and upper critical field, Bc2 was found to increase. Bc2 maximized at 1 to 1.5 at % Ga for reaction temperatures at 700 C. High critical fields up to 31.5 T (at T=4.2K) have been achieved.

23909 (AD-A-215477/1/XAB) **Superconducting electronic-film structures. Semiannual report, 1 January-30 June 1984.** Braginski, A.I.; Gavaler, J.R. Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center. 24 Jul 1984. 17p. Available from NTIS, PC A03/MF A01.

Solid state epitaxial growth of NbN single crystals have now been achieved on (1, -1,0,2) sapphire. Results indicate that surface preparation is the most critical factor in obtaining epitaxy. Films of V-Si and Nb-Ge have been reactively magnetron sputtered and the A15 phase has been obtained at temperatures as low as 290 C, approximately 150 C lower than with dc diode reactive sputtering. A LEED study of Nb3Ir single crystal epitaxial substrates lead to in-situ surface processing procedure and showed that surface reconstruction is caused by oxygen impurity. Epitaxial, single crystal Nb films have been prepared on sapphire and MgO substrates. A glancing angle XPS study of Al_2O_3 tunnel barriers and extremely thin amorphous Mo-Ge films demonstrated universality of significant thickness variation that affects tunnelling characteristics.

23910 (ANL/PPRNT–90-201) **Rotational magnetic processes in a dirty superconductor.** Liu, Liwen (Chicago Univ., IL (USA). Dept. of Physics); Kouvel, J.S.; Brun, T.O. Argonne National Lab., IL (USA). Aug 1988. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90008704. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Magnetization-vector ($\vec{M}$) measurements were made on a thin disk of impure Nb rotated relative to a fixed field $\vec{H}$ at 4.2 K. For all H, $\vec{M}$ is found to be separable into a non-rotating diamagnetic component $\vec{M}_d$ plus a penetrating-flux component $\vec{M}_p$ that turns rigidly with the sample for small rotation angles. For H below H_{c1} on a hysteresis loop, $\vec{M}_p$ diminishes in size but continues to rotate rigidly up to 360°. For H between H_{c1} and H_{c2}, $\vec{M}_p$ rotates up to and then remains at some critical angle, indicating a constant frictional torque between $\vec{M}_p$ and the sample, which presumably arises from vortex-flux jumps between pinning centers. Moreover, $\vec{M}_d$ closely equals $-\vec{H}/4\pi$ for H above as well as below H_{c1}. 6 refs., 3 figs.

23911 (ANL/PPRNT–90-207) **Analysis of the corrosion of carbon steels in simulated salt repository brines and acid chloride solutions at high temperatures.** Diercks, D.R.; Kassner, T.F. Argonne National Lab., IL (USA). Apr 1988. 32p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-31109-ENG-38. Order Number DE90009164. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

An analysis of literature data on the corrosion of carbon steels in anoxic brines and acid chloride solutions was performed, and the results were used to assess the expected life of high-level nuclear waste package containers in a salt repository environment. The corrosion rate of carbon steels in moderately acidic aqueous chloride environments obeys an Arrhenius dependence on temperature and a $(pH_2)^{-1/2}$ dependence on hydrogen partial pressure. The cathodic reduction of water to produce hydrogen is the rate-controlling step in the corrosion process. An expression for the corrosion rate incorporating these two dependencies was used to estimate the corrosion life of several proposed waste package configurations. 42 refs., 11 figs., 2 tabs.

23912 (ANL/PPRNT–90-208) **Small-angle neutron scattering studies of the template-mediated crystallization of ZSM-5 type zeolite.** Iton, L.E. (Argonne National Lab., IL (USA). Materials Science and Technology Div.); Brun, T.O.; Epperson, J.E.; Trouw, F.; White, J.W.; Henderson, S.J. Argonne National Lab., IL (USA). Mar 1988. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90009165. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Small-angle neutron scattering is a useful new approach to the study of zeolite crystallization from aluminosilicate gels and the action of template molecules. It has been applied to gels for synthesis of zeolite ZSM-5 using tetrapropylammonium ions as templates where the scattering length densities of the gel particles and their texture were determined using contrast variation methods. Gels formulated from soluble silicate incorporate template molecules promptly into an amorphous "embryonic" structure and crystallization ensues via a solid hydrogel transformation mechanism. Gels formulated from colloidal silica show different scattering behavior, and a liquid phase transport mechanism is inferred. 8 refs., 4 figs., 2 tabs.

23913 (CEA-CONF–9845) **The contribution of electronic energy losses to radiation damage in metallic materials.** Dunlop, A. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Technologie. 1989. 3p. (CONF-8905283–: SHIM 89: 1. international symposium on swift heavy ions in matter, Caen (France), 16-19 May 1989). Order Number DE90762058. Available from NTIS (US Sales Only), PC A02/MF A01.

In a cooperative program at GANIL: the damage process under very high energy Xe ions irradiation (3 GeV) with electronic slowing down in the range of 10 to 40 MeV/μm has been studied, using low temperature electrical resistance measurements, transmission electron microscopy (TEM) observations, and strain measurements, in a series of metallic materials exhibiting a large variety of electronic and structural properties: these include (i) Cu_3Au and Ni_3Fe both in the long-range ordered and disordered state, which are very similar from the cohesive energy point of view but exhibit different density of states at the Fermi level, which affects the electron-phonon coupling (ii) a model austenite (alloy $Fe_{59}Ni_{24}Cr_{17}$) which is a member of a family of alloys with a broad range of electronic properties, (iii) Ni_3B both in the crystalline and amorphous phase, Zr_3Al and NiZr crystalline and $AlMn_{21}Si_7$ quasicrystalline compounds, which are known to be easily amorphized by nuclear collisions. The main result of this investigation is that electronic slowing down has distinct effects in amorphous and crystalline metallic materials; in the former defects are clearly induced; in the latter the effects are much weaker and, depending on alloy chemistry, either consist in restoring part of the defects produced by nuclear collisions or may be in slightly enhancing the damage production (Ni_3B).

23914 (CEA-CONF–9846) **Electronic energy loss-induced effects in $Fe_{85}B_{15}$ amorphous alloys irradiated by high energy heavy ions.** Thome, L. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (FR). Section d'Etude des Solides Irradies); Lesueur, D.; Audouard, A.; Balanzat, E.; Jousset, J.C.; Fuchs, G.; Thome, L. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Section d'Etude des Solides Irradies. 1989. 3p. (CONF-8905283–: SHIM 89: 1. international symposium on swift heavy ions in matter, Caen (France), 16-19 May 1989). Order Number DE90762057. Available from NTIS (US Sales Only), PC A02/MF A01.

Amorphous $Fe_{85}B_{15}$ ribbons were irradiated at 80 and 220 K with high energy heavy ions (Ar, Kr, Mo, Xe) at the GANIL accelerator. The angle θ between the incident beam and the normal to the sample was varied between 0^0 (normal incidence) and 53^0 in order to verify the anisotropy of dimensional variations. The growth phenomenon was studied with the application of external tensile stresses (from 0 to 600 MPa) during irradiation. Electrical resistance measurements were performed in situ at the irradiation temperature.

23915 (CONF-900364–2) **Morphology of oxide scales on Ni_3Al exposed to high temperature air.** DeVan, J.H. (Oak Ridge National Lab., TN (USA)); Desport, J.A.; Bishop, H.E. Oak Ridge National Lab., TN (USA). [1990]. 11p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. From International conference on microscopy of oxidation; Cambridge (UK); 26-28 Mar 1990. Order Number DE90008909. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Microscopic observations of oxide scale growth on Ni_3Al-based alloys are described to explain the effect of temperature on scale morphologies and the beneficial effect of 8% chromium on oxidation properties at 600 to 760°C. These observations are also used to examine the role of internal oxidation processes and remedial effects of chromium on the susceptibility of Ni_3Al to grain boundary embrittlement in air at 600 to 760°C. 8 refs., 4 figs.

23916 (CONF-9003111–1-Vugraphs) **An introduction to nickel aluminide alloy.** Weir, J.R. Jr. Oak Ridge National Lab., TN (USA). [1990]. 49p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 1990 international manufacturing conference; Atlanta, GA (USA); 26 Mar 1990. Order Number DE90008565. Available from NTIS, PC A03/MF A01 - OSTI.

The properties of the alloys presented in this document were measured on an entirely new and different alloy system. The alloys are based on the intermetallic compound Ni_3Al with the substitution of alloying elements for the nickel or aluminum atoms, or both, to produce alloys of differing properties. Intermetallic compounds are brittle (including Ni_3Al). However, it has been found that by changing the composition from $Ni_{75}Al_{25}$ to $Ni_{76}Al_{24}$ and adding ~200 ppm (by weight) boron the material becomes ductile and, therefore, a potentially useful structural material. This report consists of viewgraphs for the seminar presentation "an introduction to nickel aluminide alloy."

23917 (DOE/ER/45269–T1) **Analytical electron microscopy of catalyst preparations: Progress report, July 15, 1989–July 14, 1990.** Lyman, C.E. Lehigh Univ., Bethlehem, PA (USA). 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER45269. Order Number DE90008699. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This program seeks to analyze supported metal catalysts by analytical electron microscopy (AEM) at an analytical sensitivity is pursued with the electron probe microanalyzer (EPMA) at about 10 μm resolution, while high spatial resolution is pursued with the field-emission STEM used as an AEM. The catalyst preparations examined are two important classes of pollution control catalysts. Rhodium supported on Al_2O_3 is a candidate catalyst for reduction of NO_x in flue stack gases of stationary power sources. Rh and Pt together on Al_2O_3 is a candidate catalyst for both the reduction of NO_x and the oxidation of CO and hydrocarbons in automobile exhaust. The overriding theme of this program is to use analytical electron microscopy techniques to understand elemental distributions in experimental catalysts so that catalysts with optimal microstructures can be prepared. This requires very sophisticated electron beam instrumentation to perform the analyses, an understanding of the electron beam interactions with the catalyst in the guise of electron beam damage, and a catalytic testing program to assess the success of individual experimental preparations. All of these are components of the present program.

23918 (DOE/NBM–6025618) **[Continuous casting 1985]: Foreign trip report, May 20–31, 1985.** Wilde, R.A. USDOE Idaho Operations Office, Idaho Falls, ID (USA). 12 Jun 1985. 21p. Sponsored by U.S. DOE Defense Programs. Order Number DE90008857. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The report covers the Continuous Casting '85 Conference including informal discussions with conference attendees. In general, the papers presented at the conference concerned an overview of continuous steel casting worldwide, state-of-the-art aspects of steel continuous casting technology including caster startup problems, modifications, control system strategies, energy use profiles, quality control aspects, steel chemistry control, refractories, operational aspects of continuous casters, etc. No papers were presented in the development of thin section or thin strip casting of steel. Informal discussions were held with several conference attendees including (1) Bernard Trentini, Executive Director of the Association Technique De La Siderurgie Francaise in Paris, France (similar to the American Iron and Steel Institute); (2) Dr. Wolfgang Reichelt and Dr. Peter Voss-Spilker both of Mannesmann Demag Huttentechnik -a continuous casting and other steel making machine builder in-lieu of meeting at their plant in Duisburg, FRG on May 31; (3) Ewan C. Hewitt of Devote McKee Corp., Sheffield, England; (4) Wilfried Heinemann, head of R&D Dept. at Concast Standard AG in Zurich, Switzerland; and (5) Hideo Ueno, engineer of melting section, Mitsubishi Steel Mfg. Co. Ltd, Tokyo Japan. A visit was made to the Teesside Laboratories of British Steel Corp. for discussions of their thin section casting research program in particular and R&D program in general.

23919 (EGG-M–88425) **Techno-economic assessment of a carbothermic alumina reduction process.** Kusik, C.L.; Syska, A.; Mullins, J.; Vejins, V. Little (Arthur D.), Inc., Cambridge, MA (USA). [1989]. 26p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC07-76ID01570;FG07-83ID12467. (CONF-890201–2: 118. AIME annual meeting, Las Vegas, NV (USA), 26 Feb 1989). Order Number DE90007018. Available from NTIS, PC A; GPO Dep.

Arthur D. Little, Inc., undertook an assessment of a process for the carbothermic reduction of alumina based on prior work and a flowsheet developed by a technical committee for the US Department of Energy. This paper summarizes the techno-economic assessment which identified potentially viable subprocess steps and their economic viability based on past research findings. Economic comparisons show the carbothermic process has the potential for lower capital and operating costs than the conventional Hall cell. Potential energy savings would be substantial through the use of carbothermic reduction of alumina, in the order of 230 trillion Btu's annually. However, several of the selected subprocesses have not been reduced to practice, and an opportunity exists to further improve the process economics through research and development. 11 refs., 4 figs., 7 tabs.

23920 (EGG-M–89453) **Modeling studies of electrolyte flow and bubble behavior in advanced Hall cells.** Shekhar, R.; Evans, J.W. California Univ., Berkeley, CA (USA). Dept. of Materials Science and Engineering. [1990]. 7p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC07-76ID01570. (CONF-900206–5: 119. TMS (The Minerals, Metals & Metallurgical Society) annual meeting and exhibit, Anaheim, CA (USA), 18-22 Feb 1990). Order Number DE90007013. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Much research has been carried out in recent years by corporations and university/government labs. On materials for use in advanced Hall-Heroult cells. Attention has focussed on materials for use as wettable cathodes and inert anodes and much has been achieved in terms of material development. Comparatively less attention has been devoted to how these materials might be incorporated in new or existing cells, i.e., to how the cells should be designed and redesigned, to take full advantage of these materials. The present paper describes an effort, supported by the US Department of Energy, to address this issue. The primary objectives are cell design where electrolyte flow can be managed so as to promote both the removal of the anode gas bubbles and the convection of dissolved alumina in the inter-electrode region, under conditions where the anode-cathode distance is small. The principal experimental tool has been a "water" model consisting of a large tank in which simulated anodes can be suspended in either the horizontal or vertical configurations. Gas "generation" was by forcing compressed air through porous graphite and the fine bubbles characteristic of inert anodes were produced by adding butanol to the water. Velocities were measured using a laser Doppler velocimeter. Velocity measurements with two different anode designs – one that is flat and the other that has grooves – are presented. The results show that the electrode configuration has a significant effect on the fluid flow pattern in the inter-electrode region. Furthermore, this study shows that rapid fluid flow is obtained when the cell is operated with a submerged anode. 4 refs., 12 figs.

23921 (JINR–9-88-676) **Investigation of vacuum properties of titanium alloy VT-20.** Edelmann, K. (Technische Univ., Dresden (German Democratic Republic). Abt. fuer Mathematik und Physik); Harder, U.; Mazhulin, A.V.; Antropov, V.K. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 6p. (In Russian). Order Number DE90621420. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The influence of surface treatment of VT-20 alloy on its vacuum properties was investigated. Various type of surface treatments were performed before vacuum testing: mechanical polishing and

grindin, sandblasting, chemical etching, surface processing using glow-discharge etc. Plots presenting specific gas desorption out of samples heated up to t=300 deg C are given, Chemical etching is the best way of treatment. 5 refs.; 4 figs.; 4 tabs.

23922 (Juel-Conf–77, pp. 39-75) **Horizons of powder metallurgy.** Kaysser, W.A. (Max-Planck-Institut fuer Metallforschung, Stuttgart (Germany, F.R.). Pulvermetallurgisches Lab.). Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Internationales Buero. 1989. (CONF-8904325–: 9. German-Yugoslav meeting on materials sciences and development, Hirsau (Germany, F.R.), 16-19 Apr 1989). In *Emerging materials by advanced processing. Present and future trends. Powders: Production and processing, consolidation, properties, metallic layers, phase diagrams.* Order Number DE90759592. Available from NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

The following titles of the paper show the wide scope of the subjects discussed: (1) Advanced PM materials by pressureless sintering: (a) sintering of single phase materials, (b) solid state sintering with a second phase, (c) sintering with a liquid phase. (2) Advanced PM materials by pressure assisted consolidation: (a) initial and second stage HIPing of coarse particlesw in solid state, (b) sinter-HIP and final stage HIPing of single phase W-Ni, (c) elimination of large residual pores in composite materials with a softer intergranular phase, (3) examples of advanced PM materials, (4) future of PM materials. (MM).

23923 (LA–11543-C, pp. 9-39) **Numerical experimentation: Getting the most from general purpose finite-element programs.** Flower, E. (Lawrence Livermore National Laboratory, CA (USA)). Los Alamos National Lab., NM (USA). May 1989. (CONF-880259–Summ.: Metal forming modeling (MFM) subgroup of IMOG, Los Alamos, NM (USA), 23-25 Feb 1988). In *Minutes of the meeting, Metal Forming Modeling Subgroup of IMOG, February 1988.* Order Number DE89011401. Available from NTIS, PC A14/MF A01.

Improved technology, faster and larger computers, and increased awareness of the complexity to predict metal deformation behavior during forming has led us to look at more sophisticated modeling methods. Some of these methods include crystal plasticity analysis, comprehensive internal variable constitutive laws and even atomistic modeling. Yet to the metallurgist or engineer designing metal forming tooling or investigating a proposed design for potential flaws, the continuum mechanics based finite-element (FE) method programs is a resourceful tool. The author briefly reviews the two types of FE codes applied to metal forming, ie, flow formulated and displacement based, discusses the differences between the implicit and explicit codes, reviews the essential features in NIKE2D to solve metal forming problems, points out features in NIKE2D that can be applied to parametric studies and looks at improvements that are being made in NIKE3D to speed up calculation times.

23924 (LA–11543-C, pp. 41-55) **Numerical simulation of anisotropic stretch/draw forming.** Logan, R.W.; Stout, M.G.; Korzekwa, D.A. Los Alamos National Lab., NM (USA). May 1989. (CONF-880259–Summ.: Metal forming modeling (MFM) subgroup of IMOG, Los Alamos, NM (USA), 23-25 Feb 1988). In *Minutes of the meeting, Metal Forming Modeling Subgroup of IMOG, February 1988.* Order Number DE89011401. Available from NTIS, PC A14/MF A01.

The implementation of Hill's 1948 anisotropic yield criterion into the finite-element (FEM) program NIKE2D is discussed. This program is then used to examine the effect of normal anisotropy (R) and shear anisotropy (Q_{zz}) on a hemishell stretch/drawing problem involving parts made of near-isotropic copper, and a highly anisotropic zirconium. The resulting FEM calculations and the effects of friction and anisotropy assumptions are compared. Comparison of the FEM hemishell predictions to experimental strain distributions is quite good. It is shown that for the anisotropic zirconium (R=9), an anisotropic formulation is necessary to achieve even a qualitatively correct strain distribution. The result cannot be achieved by using von Mises and altering friction coefficients, because friction plays only a minor role in this thick-sheet forming process. The hemishell simulations demonstrate the need for anisotropic yield criteria in FEM codes that also allow large deformation, rotation, and sliding, and are computationally fast enough to handle large problems.

23925 (LA–11543-C, pp. 57-85) **Site report: The finite element modeling effort at Rocky Flats.** Sackschewsky, V.; Hayer, K.; Lepi, S.; Mataya, M. Los Alamos National Lab., NM (USA). May 1989. (CONF-880259–Summ.: Metal forming modeling (MFM) subgroup of IMOG, Los Alamos, NM (USA), 23-25 Feb 1988). In *Minutes of the meeting, Metal Forming Modeling Subgroup of IMOG, February 1988.* Order Number DE89011401. Available from NTIS, PC A14/MF A01.

An overview of finite element modeling activities at the Rocky Flats Plant is presented. Major efforts to date involve modeling of metal forming processes such as forging, rolling and hydroforming. Future effort will involve comparison of predictions to actual results and developing methods to input real material behavior into the code via empirical and phenomenological equations. Although MARC/MENTAT has been in use for sometime, alternative codes are being investigated.

23926 (LA–11543-C, pp. 103-121) **Finite element simulations of isothermal and adiabatic shearing deformations.** Lipkin, J. (Sandia National Laboratories, Livermore, CA (USA)); Chiesa, M.L.; Bammann, D.J. Los Alamos National Lab., NM (USA). May 1989. (CONF-880259–Summ.: Metal forming modeling (MFM) subgroup of IMOG, Los Alamos, NM (USA), 23-25 Feb 1988). In *Minutes of the meeting, Metal Forming Modeling Subgroup of IMOG, February 1988.* Order Number DE89011401. Available from NTIS, PC A14/MF A01.

The torsional shearing deformation of thin-walled tubes of 304L stainless steel has been modeled using DYNA3D. The limiting cases of isothermal (very low loading rate) and adiabatic (very high loading rate) were simulated in an effort to compare predicted responses of the material and the specimen with experimental observations obtained at shear strain rates between 0.01 /s and 100 / s. A rate- and temperature-dependent constitutive model was used in these simulations in order to capture the strong thermomechanical coupling that has been observed in 304L. The constitutive model included internal state variables with non-liner evolution laws to characterize the history-dependence of the material. Finite deformations were treated in a way consistent with the DYNA3D computer code and the formalism of continuum mechanics. A comparison of the simulations with the experimental results reveals an excellent correlation. In particular, the development of a region of intense, localized deformation under simulated adiabitic conditions is predicted. This localization phenomenon is observed in the experiments and it leads to macro flow softening and premature failure of the specimen in test a high rates of strain.

23927 (LA–11543-C, pp. 122-146) **FE [Finite Element] modeling of a hydroforming operation.** Guerra, F.M. Los Alamos National Lab., NM (USA). May 1989. (CONF-880259–Summ.: Metal forming modeling (MFM) subgroup of IMOG, Los Alamos, NM (USA), 23-25 Feb 1988). In *Minutes of the meeting, Metal Forming Modeling Subgroup of IMOG, February 1988.* Order Number DE89011401. Available from NTIS, PC A14/MF A01.

A nonlinear, penalty function, friction algorithm was implemented in NIKE2D. A simple friction problem of a small block sliding on a larger, stiffer block was first used to verify the modifications to the code. The modified NIKE2D was then used to analyze a hydroform operation on a thin sheet of stainless steel. It was found that the experimental draw-in compared well with both the new and old friction models in NIKE2D, but that the final thickness distribution of the part did not agree as well the experimental results.

23928 (LA–11543-C, pp. 147-148) **Modeling friction in metal forming.** Wilson, W.R.D. Los Alamos National Lab., NM (USA). May 1989. (CONF-880259–Summ.: Metal forming modeling (MFM) subgroup of IMOG, Los Alamos, NM (USA), 23-25 Feb 1988). In *Minutes of the meeting, Metal Forming Modeling Subgroup of IMOG, February 1988.* Order Number DE89011401. Available from NTIS, PC A14/MF A01.

The modeling of friction on metal forming is complicated by the fact that any of a variety of lubrication regimes can exist at the tooling/workpiece interface. In each regime, different mechanisms

are reasonable for friction and different friction models are necessary. The processes by which lubricant films are formed and transported, and changes in surface roughness which occur during forming must be understood in order to determine the active lubrication regime or regimes. A strategy for using internal variables in friction modeling is described.

23929 (LA–11543-C, pp. 149) **Overview of some of the forming modeling research at Cornell University.** Korzekwa, D. Los Alamos National Lab., NM (USA). May 1989. (CONF-880259–Summ.: Metal forming modeling (MFM) subgroup of IMOG, Los Alamos, NM (USA), 23-25 Feb 1988). In *Minutes of the meeting, Metal Forming Modeling Subgroup of IMOG, February 1988.* Order Number DE89011401. Available from NTIS, PC A14/MF A01.

A short description is presented of research under the direction of Dr. Paul Dawson at Cornell University in the area of numerical implementation of constitutive behavior of materials. A viscoplastic formulation is generally used to model metal plasticity, and elasticity is sometimes included. His research includes: (1) work in predicting damage (porosity) resulting from strip drawing of metal; (Existing models for damage evolution were used and the results were compared to published experimental results. A resistance upset welding problem was modeled with a formation that coupled mechanical, thermal and electrical behavior) (2) predictions of residual stresses with a rigid-plastic formulation on loading and elastic unloading; (3) development of a model of mechanical behavior of powder at low densities; and (4) implementation of the Kocks-Canova model for texture evolution and mechanical behavior in a viscoplastic finite element code.

23930 (LA–11543-C, pp. 151-185) **Draw and stretch forming simulations with rate and temperature effects.** Logan, R.W. Los Alamos National Lab., NM (USA). May 1989. (CONF-880259–Summ.: Metal forming modeling (MFM) subgroup of IMOG, Los Alamos, NM (USA), 23-25 Feb 1988). In *Minutes of the meeting, Metal Forming Modeling Subgroup of IMOG, February 1988.* Order Number DE89011401. Available from NTIS, PC A14/MF A01.

When using coarse Finite-Element (FEM) meshes to simulate sheet metal forming, there are several aspects of the deformation that cannot be capture explicitly. The most crucial of these concern failure mechanisms; either buckling or tensile instability. Therefore, some type of approximate procedure must be generally be used to estimate the onset of buckling or local necking. This work addresses criteria used to estimate the start of local nicking, and the implications concerning stretch and draw forming. For metals with negligible strain-rate sensitivity with failure in plane strain, the onset of local necking can be shown to occur at approximately the uniform strain in a tension test. However, if the failure site is out of plan-strain, or if the material has a significant rate-sensitivity, it is best to resort to use of the Forming Limit Diagram (FLD). The FLD for a specific material is best constructed by experimentation; however, there are some general trends as to the effects of strain exponent n, rate exponent m, strain ratio R, and sheet thickness t. These are used to construct a generic scheme for estimation of the FLD given one-dimensional test results. The two criteria are then used in an FEM study to compare the effects of several material properties on performance in two forming test. One of these is Hecker's variation of the Erichsen and Olson cup tests, and the other is the Swift cup or Limiting Draw Ratio (LDR) test. When the simpler failure criterion is used, many qualitative (and quantitative) trends are lost or wrongly predicted, especially for rate-sensitive materials. It is shown that m and n both help in stretching. In drawing, higher n may be detrimental, but higher m usually helps. The R value is very important in drawing but almost irrelevant in stetching. It is also shown that the shape of the yield surface (determined by a) greatly affects drawability.

23931 (LA–11543-C, pp. 197) **Numerical simulation of casting.** Rollett, A.D. Los Alamos National Lab., NM (USA). May 1989. (CONF-880259–Summ.: Metal forming modeling (MFM) subgroup of IMOG, Los Alamos, NM (USA), 23-25 Feb 1988). In *Minutes of the meeting, Metal Forming Modeling Subgroup of IMOG, February 1988.* Order Number DE89011401. Available from NTIS, PC A14/MF A01.

Traditional simulation of metal casting has concentrated on heat flow alone. Examples are presented from experience at Los Alamos with using the ABAQUS code to model hemispheres and other shapes. The typical casting at Los Alamos is made of uranium poured into a graphite mold. This combination of materials results in comparable thermal diffusivity in the mold and the metal so that heat transfer at the metal/mold interface is important. Some preliminary work is described to measure the heat transfer coefficient at the uranium/graphite interface. Recently a cooperative effort has been developed with the Aircraft Engine Group of General Electric (AEBG). The geometry of a steeped plate mold that had been previously modeled with TOPAZ at SDRC Inc., was transferred to Los Alamos and a simulation performed with ABAQUS. Comparison of the results from the two modeling systems showed good agreement. Work is now in the two three-dimensional problems; one is a hammer casting that will be the subject of a round-robin session at the forthcoming conference on Modeling of Casting and Welding to be held in Palm Coast, Florida in April 1988. These comparisons are an important step in building confidence in the results of casting simulation. A more difficult problem in casting simulation is to model the fluid flow as well as heat flow. Development of this type of simulation is essential if modeling of defects such as laps and cold shuts is to be successful. Preliminary results are presented on modeling the early stages of fluid flow of metal into a hemispherical mold using FLOW3D.

23932 (LA–11543-C, pp. 199-209) **FE [Finite Element] modeling of drawbeads in sheet metal forming.** Maker, B.N. Los Alamos National Lab., NM (USA). May 1989. (CONF-880259–Summ.: Metal forming modeling (MFM) subgroup of IMOG, Los Alamos, NM (USA), 23-25 Feb 1988). In *Minutes of the meeting, Metal Forming Modeling Subgroup of IMOG, February 1988.* Order Number DE89011401. Available from NTIS, PC A14/MF A01.

Drawbeads are often added to the binder surfaces of sheet metal forming dies to provide increased restraining force on the sheet as it draws into the die cavity. This study uses a one dimensional finite strain shell model to represent the sheet. Realistic drawbead geometries are considered with dimensions typical of automotive applications. Experimental results, in the form of strain distribution and force - displacement diagrams, are compared to results obtained from the numerical model. Sheets of steel, brass, and aluminum are considered, in both dry and lubricated conditions.

23933 (LA–11543-C, pp. 211-240) **Computer modeling and analysis for deformation processing.** Lowe, T.C. (Sandia National Laboratories, Livermore, CA (USA)). Los Alamos National Lab., NM (USA). May 1989. (CONF-880259–Summ.: Metal forming modeling (MFM) subgroup of IMOG, Los Alamos, NM (USA), 23-25 Feb 1988). In *Minutes of the meeting, Metal Forming Modeling Subgroup of IMOG, February 1988.* Order Number DE89011401. Available from NTIS, PC A14/MF A01.

Deformation processing (e.g. rolling and forging) alters the geometry and microstructure of metals through a combination of mechanical and metallurgical processes. Traditionally, laboratories have tailored these processes to obtain optimum product quality based upon experimental studies of metallurgical processes and iterative production trails. However, trial-and-error methods to develop new forming processes may become inadequate as industry increasingly demands better performance of traditional materials and utilizes more advanced engineered materials. Computer simulation of deformation processing, including simulation of material behaviors during processing, offers a potentially cost effective means of improving existing fabrication processes and developing new processes for future production. This overview explores the use of computer simulation to aid metal forming process development.

23934 (LA–11543-C, pp. 241-260) **Application of process modelling to heat treatment of superalloys.** Wallis, R. (Cameron Iron Works, Houston, TX (USA)). Los Alamos National Lab., NM (USA). May 1989. (CONF-880259–Summ.: Metal forming modeling (MFM) subgroup of IMOG, Los Alamos, NM (USA), 23-25 Feb 1988). In *Minutes of the meeting, Metal Forming Modeling Subgroup of IMOG, February 1988.* Order Number DE89011401. Available from NTIS, PC A14/MF A01.

Finite element models using the LLNL TOPAZ and NIKE codes have been used to determine the quenching media required to give the cooling rates necessary to meet the property specifications for

superalloy components. They have also been used, qualitatively, to reduce the residual stresses developed during quenching with a subsequent reduction in distortion problems during machining. A further application has been the elimination of cracking during the quenching of crack sensitive alloys.

23935 (LA–11543-C, pp. 301) **Material optimization of uranium and uranium alloy parts.** Malone, P.A. (Y-12 Plant Development Division, Oak Ridge, TN (USA)); Vest, G.W.; Aramayo, G.A.; McTeer, S.M. Los Alamos National Lab., NM (USA). May 1989. (CONF-880259–Summ.: Metal forming modeling (MFM) subgroup of IMOG, Los Alamos, NM (USA), 23-25 Feb 1988). In *Minutes of the meeting, Metal Forming Modeling Subgroup of IMOG, February 1988.* Order Number DE89011401. Available from NTIS, PC A14/MF A01.

Metal forming simulations of uranium and uranium alloy parts continue at the Oak Ridge Y-12 Plant in Oak Ridge, Tennessee. The emphasis is on process efficiency and material reduction. The finite element modeling codes are being used to model regular production and preproduction parts for various weapons programs. The codes are used to determine near-net-shape parts with minimum stock for machining. Cost savings are based on material reduction and reduced fabrication time with estimates as high as one million dollars.

23936 (LA–11543-C, pp. 303-326) **A finite element analysis for the hydroforming of aluminum.** Lepi, S.M. (Rockwell International, Golden, CO (USA)); Hayer, L.K.; Krankota, J.L. Los Alamos National Lab., NM (USA). May 1989. (CONF-880259–Summ.: Metal forming modeling (MFM) subgroup of IMOG, Los Alamos, NM (USA), 23-25 Feb 1988). In *Minutes of the meeting, Metal Forming Modeling Subgroup of IMOG, February 1988.* Order Number DE89011401. Available from NTIS, PC A14/MF A01.

Finite element modeling of an aluminum hydroforming process, using MARC finite element software, is being investigated at Rocky Flats to aid in process development. The purpose of this analysis was to determine how well MARC predicts the final dimensions of an aluminum part formed with a VERSON hydrostatic forming press. A two dimensional, axisymmetric model was created using MENTAT mesh generating software and analyzed with MARC on a VAX 8800 mainframe computer. The analysis predicted part thickness within a five percent error band. Based upon these findings, future analyses will be conducted to optimize hydroforming process parameters.

23937 (ORNL/FTR–3566) **[Lecture on ordered intermetallic alloys]: Foreign trip report, March 4–9, 1990.** Liu, C.T. Oak Ridge National Lab., TN (USA). 20 Mar 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90009011. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler gave a week-long lecture on Ordered Intermetallic Alloys — Physical Metallurgy, Mechanical Behavior and Alloy Design at the Instituto de Pesquisas Energeticas e Nucleares, National Commission for Nuclear Energy, Brazil. While in Brazil, the traveler learned about recent research on Ni_3Al alloys and industrial interest in ordered intermetallics.

23938 (UCRL–53945) **Time-dependent failure of silver interlayer welds.** Rosen, R.S. Lawrence Livermore National Lab., CA (USA). Feb 1990. 204p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008015. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

Silver interlayer diffusion welds exhibit very high tensile strengths, despite the soft interlayer, because of the constraint provided by the stronger base metals. However, despite the high tensile strength, diffusion-welded-silver joints undergo time-dependent failure, or creep rupture at relatively low tensile stresses at ambient temperature, apparently by a ductile microvoid-coalescence mechanism at the coated and welded interfaces. Two classes of time-dependent tensile failure were investigated. In the first case, the applied stress does not produce any plastic deformation in the base metal, and rupture appears to be controlled by time-dependent plasticity within the silver interlayer as a result of the effective stress in the interlayer. The plasticity causes cavity nucleation and, eventually, coalescence and rupture. In the second case, time-dependent plasticity is observed in the base metals, and concomitant shear occurs within the soft silver interlayer under a high triaxial stress state. Here, the time-dependent plasticity of the base metal accelerates rupture. These models were substantiated by analyses of the stress and temperature dependence of the rupture times, finite-element analysis of the stress state within the interlayer, and microscopy of the fracture surfaces and interfaces loaded to various fractions of the expected rupture times. The procedures for preparing silver interlayers by planar-magnetron sputtering were developed in this research. This process was preferred over other interlayer fabrication methods, such as brazing, electrodeposition, and other physical vapor deposition processes, because of the more reproducible results obtained using planar-magnetron sputtering. The findings of this research, however, are applicable to joints in which the interlayers are prepared by these and other processes. 79 refs., 72 figs., 4 tabs.

23939 (UCRL–102016) **Microstructure of Au/Nb multilayers.** Jankowski, A.F.; Perry, P.L. Lawrence Livermore National Lab., CA (USA). Feb 1990. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900419–3: 8. international triennial conference on thin films and the 17th international conference on metallurgical coatings, San Diego, CA (USA), 1-6 Apr 1990). Order Number DE90008722. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Au/Nb multilayers are prepared using magnetron sputter deposition. The close-packed orientation of the films are revealed using x-ray diffraction. Although in bulk form (111) Au and (110) Nb have a near zero lattice misfit, the average lattice spacing of the multilayer is found to vary as a function of the direction of the composition modulation. Similar lattice distortions of the multilayer structure are known for fcc/fcc metallic superlattices, as Au/Ni. Lattice imaging of the Au/Nb multilayers, in cross-section, provides a direct means to complete an initial characterization of the atomic rearrangements in the modulation direction. 17 refs., 7 figs.

23940 (UCRL–102971) **Electronic structure, alloy phase stability, and phase diagrams.** Gonis, A. (Lawrence Livermore National Lab., CA (USA)); Sluiter, M.; Turchi, P.E.A.; Stocks, G.M.; Nicholson, D.M. Lawrence Livermore National Lab., CA (USA). 16 Feb 1990. 35p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900206–4: 119. TMS (The Minerals, Metals & Metallurgical Society) annual meeting and exhibit, Anaheim, CA (USA), 18-22 Feb 1990). Order Number DE90008306. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We review the relevance of electronic structure calculations to the determination of alloy phase stability and alloy phase diagrams. The Connolly-Williams method, the generalized perturbation method, the embedded cluster method, and the method of concentration waves are presented and their main features are discussed and compared. The results of calculations of effective cluster interactions in substitutionally disordered alloys and of phase diagrams for specific alloy systems, e.g., PdRh, PdV and AlLi, are shown and work currently in progress is briefly described.

23941 (VTT-TIED–743) **The use of hardfacing alloys in nuclear power plants.** Saarinen, K. (Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Metallilaboratorio); Aaltonen, P.; Muttilainen, E. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Aug 1987. 47p. (In Finnish). Order Number DE90621409. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In this report the structure and applications of cobalt-, nickel- and iron-based hardfacing alloys are reviewed. Cobalt-based hardfacing alloys are widely used in nuclear power plant components due to their good wear and corrosion resistance. However, the wear and corrosion products of the cobalt-containing alloys are released into the primary cooling water and transported to the reactor core where cobalt (Co-59) is transmuted to the radioactive isotope Co-60. It has been estimated that cobalt-based hardfacing alloys are responsible for up to 90% of the total cobalt released to the primary water circuit. The cobalt based hardfacing alloys are used in such components as valves, control blade pins and pumps, etc. In the Finnish nuclear power plants they are not used in in-core components. The replacement of cobalt-containing alloys in primary

cooling system components is studied in many laboratories, but substitutes for the cobalt-based alloys in the complete range of nuclear hardfacing applications have so far not been found. However, the modified austenitic stainless steels have showed good resistance to galling wear and are therefore considered substitutes for cobalt-based alloys.

23942 (ZfK–649) Binary intermetallic compounds of the actinides -Periodicity of their stability. Eichler, B.; Rossbach, H. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1988. 30p. (In German). Order Number DE90621421. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

On the basis of the Miedema model have been calculated values of the enthalpy of formation of solid binary ordered intermetallic compounds of the actinides. The essential values of the density of electrons at the Wigner-Seitz cell boundary of the pure metallic actinides have been estimated from the lattice entropy of the pure solid actinides. The calculated values were compared with experimental data from the literature. The satisfactory coincidence permit any conclusions with reference to the existence and the periodicity of the stability of intermetallic compounds even of the heavier transuranic elements and relative the compatibility of the actinides in contact with other metallic materials. (author).

23943 (ZfK–658) Metallographic investigations of the high temperature behaviour of ZrNb1. Dietrich, M. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1989. 17p. (In German). Order Number DE90621392. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The phase transformations and the material behaviour in ZrNb1-cladding were studied in the temperature range of 923 K -1373 K using metallographic investigations, differential thermal analysis, and dilatometric measurements. The phase transformation, which depends on heating atmosphere, temperature, and heating velocity, can be determined by this metallographic method. This implies that the metallographic method can be used to analyse of the damage after an accident. (author).

23944 Room temperature reaction between polycrystalline Ni/Al bilayers deposited in ultrahigh vacuum. Ruckman, M.W. (Brookhaven National Laboratory, Upton, New York 11973 (US)); Jiang, L.; Strongin, M. *Journal of Vacuum Science and Technology, A (Vacuum, Surfaces and Films) (USA),* 8(1): 134-140 (Jan 1990). DOE Contract AC02-76CH00016.

The growth of polycrystalline Ni–Al bilayers deposited in ultrahigh vacuum ($P<10^{-9}$ Torr), and their modification by annealing are studied by Auger and photoemission spectroscopy. At room temperature, Ni deposition on Al causes a chemical shift of the 68-eV Al Auger line and photoemission shows that the Ni 3*d* valence-band states for thin Ni overlayers are narrower and shifted away from E_f when compared to Ni metal. For Al deposited on Ni, the 68-eV Al Auger line also undergoes a chemical shift and photoemission shows the Ni 3*d* valence band is modified by the appearance of a new state at higher binding energy. Based on comparisons with photoemission and Auger data presented by others for Ni–Al intermetallic compounds, and photoemission, ion channeling and ion scattering results published for the chemically similar Pd–Al system, we conclude that polycrystalline Al and Ni films partially intermix and form a $NiAl_3$-like intermetallic compound at room temperature. We believe this Ni–Al compound may be found at the thin-film interface, at grain boundaries or on the surface of 3-D Ni or Al islands. Heating Ni/Al bilayers at 600 K promotes Al out diffusion and heating at higher temperatures leads to the formation of other Ni–Al compounds.

23945 Range of slow positrons in metal overlayers on Al. Nielsen, B. (Brookhaven National Laboratory, Upton, New York 11973 (USA)); Lynn, K.G.; Leung, T.C.; Van der Kolk, G.J.; Van Ijzendoorn, L.J. *Applied Physics Letters (USA),* 56(8): 728-730 (19 Feb 1990). DOE Contract AC02-76CH00016.

Polycrystalline Pd and amorphous PdTa films on Al substrates were studied by a variable energy positron beam and by Rutherford backscattering. Since positron diffusion in the overlayers is limited, the range follows directly from the Doppler broadening as a function of incident positron energy. To observe possible effects of positron backscattering, a sandwich of Al/Pd/Al was studied as well. It was found that the mean penetration depth is not described well by $\bar{z}(E)=A(\mu g/cm^2)\times E^{n(E)}$, if A and n are assumed to be material and energy independent.

23946 The effect of heat treatment on the superconducting properties of Cu-Nb composites. Klein, J.D. (EIC Laboratories, Inc., Norwood, Massachusetts 02062 (USA)); Rose, R.M. *Journal of Applied Physics (USA),* 67(2): 930-934 (15 Jan 1990).

Microfilamentary composites of continuous Nb fibers in Cu matrices were tested for superconducting transport properties after heat treatments at 200–900 °C. The critical current density at applied magnetic field was reduced dramatically as the heat treatment temperature was increased. The scaling relations describing the critical current as a function of applied field shifted from conventional $(1-h)^2$ scaling to higher-order relations as the heat treatment history was varied. Critical temperature transitions were abnormally broad in the fine-filament composites examined. The upper critical fields and transition temperatures approached bulk values after severe heat treatment.

23947 Laser shock-induced mechanical and microstructural modification of welded maraging steel. Banas, G. (Department of Civil Engineering, University of Illinois, Urbana, Illinois 61801-2397 (USA)); Elsayed-Ali, H.E.; Lawrence, F.V. Jr.; Rigsbee, J.M. *Journal of Applied Physics (USA),* 67(5): 2380-2384 (1 Mar 1990).

The effect of laser-induced high-intensity stress waves on the hardness, fatigue resistance, and microstructure in the heat affected zone of welded 18 Ni(250) maraging steel was investigated. Laser-shock processing increased the hardness and fatigue strength of the weldments. Some melting of the surface was involved during laser-shock hardening which produced the reverted austenite phase. Microscopic analyses showed an increased dislocation density in the laser-shocked area.

23948 Thermally induced structural modification of Mo-Si multilayers. Stearns, D.G. (University of California, Lawrence Livermore National Laboratory, P.O. Box 808, Livermore, California 94550 (USA)); Stearns, M.B.; Cheng, Y.; Stith, J.H.; Ceglio, N.M. *Journal of Applied Physics (USA),* 67(5): 2415-2427 (1 Mar 1990). DOE Contract W-7405-ENG-48.

The effect of elevated temperature on the structural stability and performance of Mo-Si multilayer mirrors is investigated. Mo-Si multilayers deposited by magnetron sputtering are annealed at temperatures ranging from 200 to 800 °C. A detailed and consistent picture of the thermally induced changes in the microstructure is obtained using an array of complementary measurement techniques including small- and large-angle x-ray scattering and high-resolution electron microscopy. The first significant structural changes are observed at 400 °C, characterized by an increase in the width of the amorphous interlayer regions, as well as the nucleation of microcrystallites of silicide in these regions. At higher temperature the Mo layers transform completely into polycrystalline mixtures of Mo_5Si_3 and $MoSi_2$ in both the hexagonal and tetragonal phase. The layers of silicide remain intact but exhibit a structural instability, resulting in severely warped layers surrounded by pockets of amorphous Si and voids. By 800 °C the layered structure is completely destroyed and the composition is predominately tetragonal $MoSi_2$. The performance of the multilayers as normal-incidence x-ray mirrors is measured and correlated with the observed structural modifications. Finally, our results are compared and contrasted with other annealing studies of the Mo-Si system.

23949 Microstructure of mechanically alloyed $Fe_{78}Mo_{10}Sm_{12}$ magnets with the $ThMn_{12}$ structure. Koestler, C. (Department of Materials Science and Mineral Engineering, University of California, Berkeley, CA (US)—National Center for Electron Microscopy, Lawrence Berkeley Laboratory, 1 Cyclotron Road, Berkeley, California 94720 (US)); Schulz, L.; Thomas *Journal of Applied Physics (USA),* 67(5): 2532-2539 (1 Mar 1990). DOE Contract AC03-76SF00098.

The $ThMn_{12}$-type $Fe_{78}Mo_{10}Sm_{12}$ magnet has been characterized by high-resolution electron microscopy, x-ray microanalysis, and microdiffraction. In general, the microstructure of the mechanically alloyed and annealed magnets consists of the tetragonal 1:12 matrix phase with an average matrix grain diameter of 200–300 nm and two rare-earth oxide phases, the SmO and the Sm_2O_3

phases. Microdiffraction data clearly verify the fcc structure of the single and polycrystalline SmO grains, while the Sm_2O_3 phase was found to exist only in a single-crystal hcp and monoclinic structure. In this material, no grain boundary phases at multigrain junctions were observed. The high defect concentration in the matrix grains seems to be responsible for the pinning of the domain walls and the good magnetic properties of the $Fe_{78}Mo_{10}Sm_{12}$ magnets. However, it was not possible to resolve magnetic domains by Lorentz imaging methods.

23950 Interaction of carbon monoxide with Fe(001). Brookes, N.B. (Physics Department, Brookhaven National Laboratory, Upton, New York 11973 (US)); Clarke, A.; Johnson, P.D. *Physical Review Letters (USA)*, 63(25): 2764-2767 (18 Dec 1989). DOE Contract AC02-76CH00016.

New insight into the bonding of carbon monoxide with transition-metal-surfaces is provided by spin-polarized photoemission studies of CO on Fe(001). The interaction of the molecular 5σ levels with the substrate *d* bands is found to be very weak for both tilted and vertical CO species. The former shows clear evidence for a π-*d* band interaction with discrete spin-polarized features in the occupied *D* band; the latter shows only small changes. Inverse photoemission studies (non-spin-polarized) indicate that the unoccupied 2π level is closer to the Fermi level for the tilted CO species.

23951 Scanning-tunneling-microscopy studies of Ag on Si(100)-(2×1). Samsavar, A. (Department of Physics, University of Illinois at Urbana-Champaign, 1110 West Green Street, Urbana, Illinois 61801 (US)— Materials Research Laboratory, University of Illinois at Urbana-Champaign, 104 South Goodwin Avenue, Urbana, Illinois 6180 *Physical Review Letters (USA)*, 63(26): 2830-2833 (25 Dec 1989). DOE Contract AC02-76ER01198.

The adsorption and growth of Ag on Si(100) at room temperature have been studied by scanning tunneling microscopy. The initial adsorption of Ag occurs at the two-fold bridge site in between adjacent Si dimer rows. Ag atomic chains are formed with preferred lengths. Metallic Ag islands form at coverages $\gtrsim$0.5 ML, and develop into (111)- and (110)-oriented crystallites covering the entire surface at higher coverages.

23952 Neutron powder-diffraction studies of lithium, sodium, and potassium metal. Berliner, R. (Research Reactor and Department of Physics, University of Missouri-Columbia, Columbia, Missouri 65211 (USA)); Fajen, O.; Smith, H.G.; Hitterman, R.L. *Physical Review, B: Condensed Matter (USA)*, 40(18): 12086-12097 (15 Dec 1989).

Neutron powder-diffraction measurements have been performed on polycrystalline lithium and sodium specimens at 80 and 20 K and on potassium metal at 80 and 10 K. Lithium is bcc (body-centered cubic) at room temperature and undergoes a martensitic structural phase transformation to a 9*R* (samarium-type) form at low temperature. This experiment presents evidence that the 9*R* phase is present in sodium as well as lithium. No evidence of a transformation was observed in potassium at 10 K. The diffraction lines for both lithium and sodium after the phase transformation exhibit position shifts and broadening characteristic of stacking-fault defects. The line shifts, line broadening, and transformed fraction for the low-temperature phase of lithium and sodium metal are reported. The diffraction peak position shifts are, however, different from those predicted for deformation-type stacking faults alone. Qualitative agreement of the experimental results with stacking-fault-model calculations was obtained for a "double-twin" type of layer defect.

23953 Tight-binding coherent-potential approximation including off-diagonal disorder. Papaconstantopoulos, D.A. (Complex Systems Theory Branch, Naval Research Laboratory, Washington, D.C. 20375-5000 (USA)); Gonis, A.; Laufer, P.M. *Physical Review, B: Condensed Matter (USA)*, 40(18): 12196-12200 (15 Dec 1989).

We present a generalization of the tight-binding coherent-potential approximation (TB-CPA) to substitutionally disordered alloys with both diagonal and off-diagonal disorder (ODD), taking into account all relevant *s*, *p*, and *d*, orbitals. This generalization is based on the work of Blackman, Esterling, and Berk [Phys. Rev. B 4, 2412 (1971)] which treated ODD within a single-band model of a disordered alloy. The method is illustrated with calculations of the density of states of disordered $Cu_{0.75}Pd_{0.25}$ alloys. We find that inclusion of ODD improves the agreement with specific-heat data, but it does not resolve a discrepancy with the results of first-principles, muffin-tin CPA calculations regarding the Pd component of the density of states.

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Refer also to citation(s) 23670, 23909, 24072, 24194, 24875, 25189

23954 (AD-A-215283/3/XAB) **Experiments on large single crystals of the superconducting oxides $YBa_2Cu_3O_7$, La(2-x)Ba(x)CuO_4, and BICa-Sr-Cu-O. Final report, 2 October 1988-28 February 1989.** Ong, N.P. Princeton Univ., NJ (USA). Dept. of Physics. 30 Oct 1989. 4p. Available from NTIS, PC A01/MF A01.

The growth and characterization of single crystals of the high temperature superconductors was investigated. High temperature, high pressure annealing of crystals of YBCO was carried out and found to be ineffective in further raising the Tc of the crystals beyond 93 K. Torque magnetometry measurements on YBCO crystals showed that the coherence length anisotropy is 5.5, independent of temperature in the range 80 to 90 K. The growth of the 40 K system based on LaCuO doped with Ba, was attempted. Large crystals were obtained, but the Ba content (x approx. 0.5) was too high to sustain high temperature superconductivity. Keywords: Yttrium barium copper oxides, Lanthanum copper oxides, Bismuth calcium strontium copper oxides.

23955 (AD-A-215491/2/XAB) **High temperature superconductivity. Annual report for period ending 30 June 1989.** Eckstein, J.N. Varian Associates, Inc., Palo Alto, CA (USA). Varian Research Center. 30 Jun 1989. 7p. Available from NTIS, PC A02/MF A01.

The overall goals of this program are to develop the technology of MBE growth of HTSC material, to optimize the performance of HTSC films with high transition temperatures and critical current densities, and to explore the development of electronic devices based on such material. In-situ growth of (BiO)2-containing HTSC material was obtained. Attempts are being made to perfect the process in order to improve the superconducting properties of the films. (BiO)2 containing layered superconducting films grown in-situ at low temperature were obtained without any post-growth anneal. This result was obtained recently on two films grown under nominally identical conditions using ozone as a source of active oxygen. To our knowledge, these are the first films from the (BiO)2 family grown in-situ by an evaporative technique, and the first such films grown in-situ by any technique in the U.S. The films were grown on SiTiO3 by atomic layer epitaxy (ALE) and exhibited a streaky RHEED pattern throughout growth, indicating the heteroepitaxy of a single-crystal-like and atomically smooth layer. X-ray diffraction analysis revealed the films to be completely aligned, as layered by the beam-shuttering sequence, and nearly single phase.

23956 (AD-A-215510/9/XAB) **Possible observation of a spin-density wave in La_2CuO_4 by Raman scattering.** Zeiger, H.J.; Strauss, A.J.; Dresselhaus, G.F.; Liu, Y.C.; Picone, P.J. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. 1 Nov 1989. 9p. (JA-6222). Available from NTIS, PC A02/MF A01.

Pub. in Physical Review B, Vol. 40, No. 13, 8891-8898(1 Nov 1989).

The multipeaked Raman spectrum in samples of La_2CuO_4 in the region from 300 to 1420/cm is modeled. We report a striking example of such a spectrum from room temperature to 500 K in a single-crystal sample. An explanation of the spectrum is proposed based on the allowed excitation of spin-wave modes in the presence of a spin-density wave. The role of the dynamic spin-correlation length in broadening the spin-wave spectrum and in affecting the temperature and sample dependence of the spectrum is also discussed.

23957 (ANL/PPRNT-90-203) **A new interpretation of grain boundary disordering at high temperatures.** Lutsko, J.F.; Wolf, D. Argonne National Lab., IL (USA). Jun 1988. 15p. Sponsored by

U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90008706. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

It is suggested that the disordering of grain boundaries at high temperatures, which has been observed in previous computer simulations and interpreted as a "premelting" transition, is related to the frustration of grain boundary migration due to restricted translational freedom in these simulations. 11 refs., 5 figs.

23958 (ANL/PPRNT–90-204) **Synthesis of Bi-Sr-Ca-Cu oxide superconductor by solution technique.** dos Santos, D.I.; Balachandran, U.; Lanagan, M.T.; Shi, D.; Pate, M.A.; Poeppel, R.B. Argonne National Lab., IL (USA). [1990]. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90008707. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Superconducting $Bi_2Sr_2Ca_2Cu_3O_x$ powders have been synthesized using a solution technique in which bismuth nitrate, strontium hydroxide, calcium acetate and copper ethoxide were dissolved in a glacial acetic acid-ethanol mixture. The resulting solution was evaporated to dryness to obtain pale blue powder. This powder was calcined and pressed into pellets and sintered at 860°C in air. The resistance of these samples indicated an on-set of 110 K and reached zero electrical resistance state at about 70 K. 21 refs., 3 figs.

23959 (CEA-CONF–9881) **Irradiation damage in superconductors.** Quere, Y. Ecole Polytechnique, 91 - Plaiseau (France). Lab. CEA d'Etudes des Solides Irradies. 1989. 9p. (CONF-8905292–: Conference on cathodic sputtering, Donji-Milanovac (Yugoslavia), 8-11 May 1989). Order Number DE90762007. Available from NTIS (US Sales Only), PC A02/MF A01.

Most superconductors are quite sensitive to irradiation defects. Critical temperatures may be depressed, critical currents may be increased, by irradiation, but other behaviours may be encountered. In compounds, the sublattice in which defects are created is of significant importance. 24 refs.

23960 (CEA-CONF–9899) **Microstructure, mechanical properties and oxidation behavior of hot isostatic pressed tantalum nitride.** Montintin, J.; Desmaison-Brut, M.; Boncoeur, M.; Valin, F. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Physico-Chimie. 1989. 6p. (CONF-890622–: 2. international conference on hot isostatic pressing theory and applications, Gaithersburg, MD (USA), 7-9 Jun 1989). Order Number DE90762045. Available from NTIS (US Sales Only), PC A02/MF A01.

Hot isostatic pressing has been successfully applied for the consolidation of TaN powder which does not contain additives. Highly dense material was obtained at 1600°C and 185 MPa using a suitable encapsulation technique. Correlative relations between the mechanical properties and the porosity of the nitride were established. Significant oxidation was observed in a dynamic flow of oxygen due to the non protective character of the oxide scale.

23961 (JINR-R–14-88-572) **The effect of irradiation on current-voltage characteristics of $YBa_2Cu_3O_7$ high temperature superconducting ceramics.** Zajtsev, L.N. (Moskovskij Inzhenerno-Fizicheskij Inst., Moscow (USSR)); Smirnov, V.I.; Reshetnikov, G.P. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 9p. (In Russian). Order Number DE90621440. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Current-voltage charateristics (CVC) of high-temperature superconducting cermaics $YBa_2Cu_3O_7$ irradiated by fast protons and carbon nuclei have been studied experimentally. The aim of work was to determine the dependence of degradation of critical current of high temperature superconductors (HTS) on dose. Samples of HTS ceramics were irradiated on the extracted beams of protons and ^{12}C at room temperature. Measurement of CVC were carried out by 4-contact method in a nitrogen bath. At 77 K the dependence of critical current degradation of HTS ceramics on dose due to proton irradiation is obtained. It is established that HTS are more sensitive to proton irradiation as compared with superconductors on the base of NbTi alloy. 8 refs.; 4 figs.; 2 tabs.

23962 (LA–11768-MS) **SESAME equation of state number 7611, beryllium oxide.** Boettger, J.C.; Willis, J.M. Los Alamos National Lab., NM (USA). Apr 1990. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE90008519. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A new equation of state (EOS) for beryllium oxide (BeO) has been constructed for the SESAME library as material number 7611. Unlike the existing EOS for BeO in the library (7610), this new EOS incorporates the effect of a structural phase transition which has been predicted by two independent theoretical calculations. 9 refs., 1 fig.

23963 (LA-UR–90-449) **Synthesis and properties of polycrystalline $Tl_2Ba_2CaCu_2O_x$ and $Tl_2Ba_2Ca_2Cu_3O_x$.** Vogt, G.J.; Phillips, D.S. Los Alamos National Lab., NM (USA). [1990]. 24p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-7405-ENG-36. (CONF-900287–1: TMS symposium on high temperature superconducting compounds, Anaheim, CA (USA), 20-21 Feb 1990). Order Number DE90007528. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Polycrystalline samples of $Tl_2Ba_2CaCu_2O_x$ and $Tl_2Ba_2Ca_2Cu_3O_x$ superconductors with high (>95 wt %) phase purity were prepared by a solid state reaction of Tl_2O_3 with a mixture of $BaCuO_2$, Ca_2CuO_3, and CuO. Starting compositions of $Tl_{1+\delta}BaCaCu_2O_x$ and $Tl_{2+\delta}Ba_2Ca_2Cu_3O_x$ were fired in semi-sealed reaction vessels for durations of 12 to 48 hours in flowing oxygen with low, reproducible thallium losses. Samples fired at temperatures below 870°C produced predominately the 2212 phase, while samples above 870°C yielded the 2223 phase. While pressed mixed oxides reacted in a single firing step produced low-density (≤50% theoretical) material, samples prepared by a two-step sequence of reactive calcination, intermediate grinding, and sintering yielded higher density material (>70% theoretical). The sintered polycrystalline superconductors were characterized by x-ray diffraction, reflected light and electron microscopy, magnetic susceptibility, and dc transport resistivity. Critical current density measurements by direct transport and magnetic moment hysteresis methods are presented for the denser samples. Transport J_c values up to 300 A/cm^2 at 75 K were observed for moderately dense material (5.2 g/cm^3, 74% theoretical) in transverse H fields up to 10 kOe. 10 refs., 16 figs.

23964 (ORNL/FTR–3572) **[Research advances in fine ceramics]: Foreign trip report, March 9–18, 1990.** Becher, P.F. Oak Ridge National Lab., TN (USA). 2 Apr 1990. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008983. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler attended both the International Forum on Fine Ceramics and the International Fine Ceramics Workshop in Nagoya, Japan. The Forum speakers presented overviews on research advances in the development of and the economics of electronics, ceramics, hard materials, and structural ceramics. The Workshop was devoted to presentations on recent research findings primarily on the mechanical behavior and processing of structural ceramics. The traveler presented two invited talks: one on the toughening behavior of whisker-reinforced ceramics, and one on mechanical properties at elevated temperatures. He also held separate discussions with researchers from Nippon Kokan K.K. (NKK) and Toshiba on their research on the properties of silicon nitride ceramics. These researchers and those of other Japanese laboratories have made excellent progress in developing silicon nitride ceramics with high fracture toughness/resistance which also appear to have promising properties at elevated temperatures.

23965 (PNL-SA–17226) **Vibrational spectroscopy of boron nitride at high temperatures and pressures.** Exarhos, G.J. (Pacific Northwest Lab., Richland, WA (USA)); Hess, N.J. Pacific Northwest Lab., Richland, WA (USA). Dec 1989. 6p. Sponsored by U.S. DOE Energy Research; Northwest College and University Association for Science. DOE Contract AC06-76RL01830. (CONF-891119–113: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989). Order Number DE90008633. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Raman scattering measurements are used to distinguish between amorphous and crystalline phases in sputter deposited

boron nitride coatings and bulk materials. Changes in vibrational line frequency and linewidth can be attributed to differences in particle size or inherent strain which can be quantified from pressure-dependent measurements of the bulk material. The response of the Raman-allowed E_{2g} modes (hexagonal phase) to temperature is described by a forced damped harmonic oscillator model from which the intra- and interplanar lattice thermal expansion can be estimated. 12 refs., 3 figs., 1 tab.

23966 (PNL-SA-17271) **Ceramic oxide thin film formation utilizing biological processes.** Tarasevich, B.J.; Rieke, P.C. Pacific Northwest Lab., Richland, WA (USA). Jan 1990. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. (CONF-891119-112: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989). Order Number DE90008599. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Mineralization processes used by bioorganisms have been adapted for the nucleation and growth of ceramic oxide thin films onto surfaces from aqueous solutions. These strategies include the use of surfaces derivatized with specific functional groups that control the nucleation and growth and properties of materials deposited. Initial experiments have involved the precipitation of iron oxide materials onto functionalized polystyrene surfaces. Deposition resulted in the formation of thin films composed of densely packed, nanometer-sized crystallites and evidence for the formation of oriented crystallites was found. This process may have advantages over conventional thin film processing methods due to the ability to systematically control surface properties to systematically control properties of materials deposited. 23 refs., 1 fig.

23967 (PNL-SA-17450) **Results from a 100-hour electrolysis test of cermet anode: Materials aspects.** Strachan, D.M. (Pacific Northwest Lab., Richland, WA (USA)); Koski, O.H.; Morgan, L.G.; Westerman, R.E.; Peterson, R.D.; Richards, N.E.; Tabereaux, A.T. Pacific Northwest Lab., Richland, WA (USA). Feb 1990. 8p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. (CONF-900206-6: 119. TMS (The Minerals, Metals & Metallurgical Society) annual meeting and exhibit, Anaheim, CA (USA), 18-22 Feb 1990). Order Number DE90008627. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Extensive materials examination were conducted following testing of a 15-cm-diameter prototype cermet anode. The anode was cut in half and samples were taken that were above, at, and below the electrolyte. The microstructure and phases were found to be different in each of these areas. For instance, the copper oxidized to CuO above the electrolyte, but Cu_2O appeared to be the favored oxidation product in the anode sample in the electrolyte. 9 refs., 14 figs.

23968 Diffuse scattering from $YBa_2Cu_3O_{7-\delta}$ oxide caused by Magneli-type plane defects. Khachaturyan, A.G. (Department of Mechanics and Materials Science, Rutgers University, Post Office Box 909, Piscataway, New Jersey 08855-0909 (USA)); Morris, J.W. Jr. *Physical Review Letters (USA),* 64(1): 76-79 (1 Jan 1990). DOE Contract AC03-76SF00098.

It is shown that if a periodical faulting of the double-period orthorhombic (1/200) phase in $YBa_2Cu_3O_{7-\delta}$ produces a Magneli series, $YBa_2Cu_3O_7(n)/(2n+1)$, with a regular superlattice spots at $[1/2+1/2(2n+1),0,0]$, the random faulting results in either broadening the (1/200) diffraction maximum or its splitting into two maxima, $(1/2\pm\epsilon,0,0)$, depending on the stoichiometry. The observation of these effects is a strong argument in favor of an assumption that this compound is inherently inhomogeneous due to the accommodation of nonstoichiometry by means of the formation of interstitial plane defects.

23969 Pressure dependence of T_c in $L_{2-x}M_xCuO_{4-y}$ (L=Pr,Nd,Sm,Eu; M=Ce,Th): Antisymmetric behavior of electron- versus hole-doped copper-oxide superconductors. Markert, J.T. (Department of Physics and Institute for Pure and Applied Physical Sciences, University of California, San Diego, La Jolla, California 92093 (USA)); Beille, J.; Neumeier, J.J.; Early, E.A.; Seaman, C.L.; Moran, T.; Maple, M.B. *Physical Review Letters (USA),* 64(1): 80-83 (1 Jan 1990).

Measurements of the superconducting transition temperature T_c in the electron-doped copper-oxide compounds $L_{2-x}M_xCuO_{4-y}$ under pressure P to ~20 kbar reveal that, in general, T_c decreases with P, in contrast to the behavior of hole-doped copper-oxide compounds. The quantity $d\ln T_c/d\ln V$ exhibits a dependence on T_c similar to that of hole-doped compounds, but opposite in sign, and can be as large as ~24. Correlation of structural and transport properties indicates competition between interlayer and intralayer effects in these materials.

23970 The Richtmyer Memorial Lecture (January 1989): Novel magnetic phenomena and high-temperature superconductivity in lamellar copper oxides. Birgeneau, R.J. (Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (US)—Department of Physics, Brookhaven National Laboratory, Upton, New York 11973 (US)). *American Journal of Physics (USA),* 58(1): 28-40 (Jan 1990). DOE Contract AC02-76CH00016.

The discovery of high-temperature superconductivity in lamellar copper oxide materials is one of the most dramatic and unexpected events in physics in the last several decades. In this paper, which is the text of the 48th Richtmyer Lecture, the basic physics of this new phenomenon is discussed and it is explained why the problem is proving to be so difficult in spite of the unprecedented assault on it by many thousands of physicists, chemists, and materials scientists.

23971 Thermodynamic Functions and Properties of MgO at High Compression and High Temperature. Anderson, O.L. (Institute of Geophysics and Planetary Physics and Department of Earth and Space Sciences, University of California, Los Angeles, California 90024 (US)); Zou, K. *Journal of Physical and Chemical Reference Data (USA),* 19(1): 69-83 (Jan 1990).

The complete thermodynamic functions for MgO are presented for the temperature range 300–2000 K and the pressure range 0–150 GPa, both as tables and as graphs. Careful attention is given to the temperature and pressure dependence of the coefficient of thermal expansion α and the isothermal bulk modulus K_T, which are the major corrections to the thermodynamic functions in extreme conditions. Our equations efficiently use the fact that the product αK_T varies only slightly with either temperature or with volume, although scrupulous care is taken to account for the actual numbers. The corrections are now possible due to recent measurements of the bulk modulus up to 1800 K. The Birch–Murnaghan equation of state is used to account for certain terms in the expressions for internal energy and enthalpy. The parameters used in the Birch–Murnaghan equation of state are given as functions of temperature. The parameters which presently limit the calculations of thermodynamic functions to even higher temperatures and pressures and limit the applications of this method to other minerals are: (1) the uncertainty of the thermal expansivity at temperatures above 1500 K, and (2) the uncertainty of the temperature dependence of $(\partial K_T/\partial T)_P$ at temperatures above 800 K.

23972 Characterization of silicon nitride particles synthesized in an atmospheric-pressure convection-stabilized arc. Chang, YI (Univ. of Minnesota, Minneapolis (USA)); Kong, P.; Pfender, E. *Plasma Chemistry and Plasma Processing (USA),* 9(1): 73-93 (Mar 1989). DOE Contract FG02-85ER13433.

Silicon nitride powders were synthesized in an atmospheric-pressure convection-stabilized arc using silicon and ammonia as reactants. The morphology and particle size distributions of the silicon nitride particles were characterized by SEM, TEM, and electron diffraction analyses. The silicon nitride particles collected in the plasma reactor were formed by either gas-condensed phase reactions or chemical vapor reactions. The morphologies of the particles formed by gas-condensed phase reactions consisted of β-Si_3N_4 prisms, α-Si_3N_4 matte, α-Si_3N_4 needles, and spaghetti-like whiskers. For the homogeneously nucleated particles, the morphologies included dendrites, needles, platelets, and amorphous particles. Most of the particles formed were aggregates with particle size distributions ranging from 500 to 1,500 Å depending on the location of injection of the reactants.

23973 Silicon nitride synthesis in an atmospheric pressure convection - Stabilized arc. Change, YI (Univ. of Minnesota, Minneapolis (USA)); Young, R.M.; Pfender, E. *Plasma Chemistry and Plasma Processing (USA),* 9(2): 277-289 (Jun 1989). DOE Contract FG02-85ER13433.

Submicron α-, β-, and amorphous-phase silicon nitride particles have been synthesized in an experimental plasma reactor, using metallic silicon and ammonia as reactants. Injection of ammonia at different locations of the reactor results in different yields. A maximum yield of 85 wt% has been achieved by injecting NH_3 at both downstream and upstream locations of the reactor. The powders synthesized in this way contained approximately 60 wt% silicon nitride in crystal form with equal amounts of α and β phases. The remainder consisted of the amorphous phase. The average size of the particles ranged from 50 to 90 nm, with a standard deviation of 1.47-1.87 depending on the location of ammonia injection. Seeding with 1 and 10 wt% of preexisting silicon nitride particles for fostering heterogeneous nucleation did not improve the yield, but it changed the particle size distribution.

23974 Effects of silver doping in the high-T_c superconductor system Y-Ba-Cu-O. Kao, Y.H. (Department of Physics, State University of New York at Stony Brook, Stony Brook, New York 11794-3800 (USA)); Yao, Y.D.; Jang, L.Y.; Xu, F.; Krol, A.; Song, L.W.; Sher, C.J.; Darovsky, A.; Phillips, J.C.; Simmins, J.J. *Journal of Applied Physics (USA),* 67(1): 353-361 (1 Jan 1990). DOE Contract FG02-87ER45283.

Changes in various superconducting properties as a function of silver substitution in the bulk granular high-T_c system Y-Ba-Cu-O have been investigated. In the low doping limit, Ag impurities behave as an excellent oxygen stabilizer and the critical current density is enhanced by an order of magnitude while the T_c remains practically unchanged. When the Ag content is increased to above 20%, the T_c starts to drop and the effects of Ag clusters as well as impurity phases become more important. However, the compound is still a superconductor with a T_c around 20 K by full substitution of Ag for Cu. The problems concerning the location of Ag atoms and formation of Ag clusters are examined with measurements of x-ray absorption fine structure using synchrotron radiation. Our results indicate that at least some Ag atoms occupy the Cu(1) and Cu(2) sites in the material. Magnetic field dependence shows that the critical current density of a bulk sintered high-T_c superconductor below a characteristic value H'_c is mainly controlled by intergranular weak-link coupling. A shift of H'_c with the addition of Ag helps explain the variation of critical current density in this compound system.

23975 Spin fluctuations in superconducting $YBa_2Cu_3O_{6.5}$. Tranquada, J.M. (Brookhaven National Laboratory, Upton, New York 11973 (US)— Atomic Energy of Canada Limited, Chalk River, Ontario, Canada K0J1J0— McMaster University, Hamilton, Ontario, Canada L8S4M1— Institute for Molecular Science, Okazaki 444, Japan); *Physical Review Letters (USA),* 64(7): 800-803 (12 Feb 1990).

Antiferromagnetic spin fluctuations in superconducting $YBa_2Cu_3O_{6+x}$ have been studied using inelastic neutron scattering. In a crystal with x=0.5 and T_c=50 K, we have observed spin fluctuations at 12 K having a cross section which increases with increasing excitation energy. The data are consistent with highly overdamped spin waves and a very short spin-spin correlation length.

23976 Pressure tuning of interatomic interactions in solids: Glassy properties of ferroelectrics and dielectrics. Samara, G.A. (Sandia National Labs., Albuquerque, NM (USA)). *Journal of Physical Chemistry (USA),* 94(3): 1127-1134 (8 Feb 1990). DOE Contract AC04-76DP00789.

Frustration-induced disorder and impurity-induced disorder can lead to the formation of a glassy state in ferroelectric (FE) and antiferroelectric (AFE) crystals. This paper compares the glassy properties of a mixed hydrogen-bonded FE and AFE crystal $[Rb_{1-x}(NH_4)_xH_2PO_4]$ which exhibits frustration-induced disorder with those of a perovskite with dilute substitutional impurities ($KTa_{1-x}Nb_xO_3$ for $x \leq 0.02$). The emphasis is on the important role of pressure in delicately tuning interatomic interactions and in understanding the short-range interactions and correlations responsible for the glassy state. It will be shown that modest pressures can suppress this state in both systems and that the manner in which the dynamic glass transition temperature vanishes with increasing pressure is indicative of the nonequilibrium nature of the glass transition. The properties of these novel glassy systems are contrasted with those of more conventional orientational glasses in, e.g., inorganic crystalline solids $[KBr_{1-x}(CN)_x]$ and organic polymers (poly(vinylidene fluoride)), and it is shown that the pressure effects on the two classes are qualitatively different. A novel pressure-induced crossover from long-range FE order to glassy behavior is also discussed.

23977 Effects of indium and tin overlayers on the photoluminescence spectrum of mercuric iodide. James, R.B. (Advanced Materials Research Division, Sandia National Laboratories, Livermore, California 94550 (USA)); Bao, X.J.; Schlesinger, T.E.; Ortale, C.; Cheng, A.Y. *Journal of Applied Physics (USA),* 67(5): 2571-2575 (1 Mar 1990).

Mercuric iodide (HgI_2) crystals with semitransparent metal overlayers of indium and tin were characterized using low-temperature photoluminescence (PL) spectroscopy. The PL spectra were found to differ for points beneath the thin metal overlayers and points that were masked off during each deposition. The photoluminescence data were compared with PL measurements taken on HgI_2 photodetectors with indium-tin-oxide (ITO) entrance electrodes. The similarities of the spectra for the HgI_2 samples with In, Sn, and ITO conducting overlayers indicate that the regions in the ITO-contacted photodetectors with relatively poor photoresponses are associated with the interaction of indium or tin with the mercuric iodide substrate.

23978 Solid-state reactions in high-temperature superconductor-ceramic interfaces; Y-Ba-Cu-O on Al_2O_3 versus yttria-stabilized ZrO_2, and MgO. Fartash, A. (University of California, San Diego, Physics Department B-019, La Jolla, California 92093 (USA)); Schuller, I.K.; Pearson, J. *Journal of Applied Physics (USA),* 67(5): 2524-2527 (1 Mar 1990). DOE Contract W-31-109-ENG-38.

We have prepared, using molecular-beam epitaxial techniques, superconducting Y-Ba-Cu-O films directly on Al_2O_3, yttria-stabilized ZrO_2 (YSZ), and MgO without buffer layers. The structure and stoichiometry of the films on Al_2O_3 are compared with those prepared on YSZ and MgO and found in large part determined by reactions with the substrates. The films on Al_2O_3 consist of textured $Y_2Ba_4Cu_8O_{20-x}$ with superconducting onset at 80 K and zero resistance at 69 K, whereas on YSZ and MgO, $YBa_2Cu_3O_{7-z}$ films are formed. Auger electron depth profile spectroscopy in conjunction with structural and transport studies suggest that copper is depleted from the region near the Al_2O_3 substrate.

23979 The effect of heat-treatment environment on the superconducting properties of plasma-sprayed $YBa_2Cu_3O_y$ deposits. Gudmundsson, B. (Department of Materials Science and Engineering, State University of New York at Stony Brook, Stony Brook, New York 11794 (USA)); Wang, H.; Neiser, R.A.; Katz, B.; Herman, H.; Suenaga, M. *Journal of Applied Physics (USA),* 67(5): 2653-2655 (1 Mar 1990). DOE Contract AC02-76CH00016.

Plasma-sprayed $YBa_2Cu_3O_y$ coatings consist of a nonsuperconducting tetragonal phase with an *a/c* ratio of 1/3 (*c*=11.61) in the as-sprayed condition. This phase is tentatively assigned to the solid solution $Y_1(Ba_{2-x}Y_x)\ Cu_3O_{7+\delta}$. Heat treatment of this phase at 930 °C/24 h in oxygen results in orthorhombic symmetry, an expansion of the *c* axis (11.66 A), and the appearance of superconductivity. In this study it is shown that heat treatment in argon at 850 °C prior to the oxygen heat-treatment leads to a crystal structure which closely matches the desired $YBa_2Cu_3O_y$ (*c*=11.68), raises T_c, and narrows the transition width.

23980 Oxygen chemisorption and laser Raman spectroscopy of unsupported and silica-supported vanadium oxide catalysts. Oyama, S.T. (Lawrence Berkeley Lab., CA (USA)); Went, G.T.; Lewis, K.B.; Bell, A.T.; Somorjai, G.A. *Journal of Physical Chemistry (USA),* 93(18): 6786-6790 (7 Sep 1989). DOE Contract AC03-76SF00098.

An oxygen chemisorption method has been developed for measuring the active surface area of supported and unsupported V_2O_5 following reduction in hydrogen. It is shown that to achieve complete reduction of the vanadia surface without reducing the bulk, reduction must be carried out at 640 K. Oxygen uptakes of unsupported samples reduced at close to this temperature yield an oxygen atom site density of 3.2×10^{18} m^{-2}, a value near that expected for a monolayer. The same oxygen chemisorption technique is applied to silica-supported V_2O_5. Laser Raman spectroscopy confirms that, near 640 K, oxygen chemisorbs primarily at the surface of the dispersed vanadia but does not exchange with the bulk of the oxide. For very low weight loadings, a limiting stoichiometry of one adsorbed oxygen atom per vanadium atom is obtained. This stoichiometry is used to calculate dispersions ranging from 92% to 50% for supported V_2O_5 samples of 0.3-9.8% weight loading.

3606 Other Materials

Refer also to citation(s) 23886, 23900, 23904, 23905, 23950, 24067, 24068, 24113, 24188, 24331

23981 (AD-A–215448/2/XAB) **High modulus coatings. Progress report, 1 October 1988-30 September 1989.** Tustison, R.W. Raytheon Co., Lexington, MA (USA). Research Div. 13 Oct 1989. 8p. Available from NTIS, PC A02/MF A01.

Mechanisms are explored by which the ultimate fracture strength of ZnS can be increased without degrading it's optical transparency in the bandpass of interest. Relatively thin films of Y_2O_3 could be used to strengthen substrates of ZnS. The observed strengthening effect was shown to be related to the intrinsic compressive stresses in the film. The magnitude of the strengthening is relatively independent of film thickness, deposition method (i.e. magnetron vs.ion beam sputtering) and even film composition, depending only on the sign of the film stress. For example, the strengthening effect was not observed in ZnS samples coated with evaporated YF3 films, wherein the intrinsic film stresses were found to be tensile. Ion assisted evaporation of the same material resulted in the creation of new compressive stresses and the substrate strengthening effect was again observed. In all cases the observed effect was found to be a 25-35% increase which is in agreement with a model wherein flaws originally residing at the surface of a brittle material like ZnS are internalized.

23982 (AD-A–215710/5/XAB) **Low-temperature photoluminescence study of uranium implanted into III-V semiconductors and algaas. Master's thesis.** Scott, M.B. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. 4 Dec 1989. 67p. (AFIT/GEP/ENP–89D-9). Available from NTIS, PC A04/MF A01.

Actinides, like lanthanides, have a partially filled inner shell (5f for actinides) so that semiconductors implanted with these elements should have sharp emissions characteristic of the atomic transitions of the free element ions. In this work, II-V semiconductors Gallium Arsenide, Gallium Phosphide, and Indium Phosphide and ternary Al(0.15)Ga(0.85)As were ion implanted with Uranium 238. Uranium-associated emissions were observed in the near infrared region in each semiconductor type except for n-type GaP. The uranium emissions in n-type GaP were too weak to confirm. An annealing temperature dependence study and a sample temperature dependence study were done to associate emissions to specific centers and observe thermal quenching. No effects by the doping of uranium were observed in the band edge emissions except in semi-insulating (SI) InP:U. The optimum annealing temperature for SI-GaAs, SI-InP, and n-type Al(0.15)Ga(0.85)As was 700 C. For n-type GaAs, the optimum annealing temperature was 750 C. The increase in emission intensities with higher annealing temperature suggests a lattice site luminescence center. The similar intensity dependence on sample temperature by each Uranium emission in each semiconductor, implies a single luminescence center. The weakness of uranium emissions shows that uranium-doped semiconductors must be modified to significantly improve the quantum efficiency of the radiation transfer process before they can be seriously considered for use in devices.

23983 (BNL–43937) **Hypothetical two and three dimensional channel zeolite framework structures.** Kokotailo, G.T. (British Columbia Univ., Vancouver, BC (Canada). Dept. of Chemistry); Fyfe, C.A.; Gies, H.; Cox, D.E. Brookhaven National Lab., Upton, NY (USA). [1989]. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-890705–3: 8. international zeolite conference, Amsterdam (Netherlands), 10-14 Jul 1989). Order Number DE90008576. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Hypothetical framework structured with intersecting channel systems consisting of 7, 8, 9, 10, 11 and 12 membered rings (MR) are described. These frameworks are related to known structures by the rotation or sliding of layers or chains and also formed by alternative linkage patterns of known building units; chains and building blocks. Since 5 MR have been found to contribute to thermal and hydrothermal stability as well as higher Si/Al ratios, the emphasis is on frameworks with a higher concentration of 5 MRs. Frameworks with varied channel shapes are also described. The hypothetical structures discussed are not intended to be an enumeration of all possible nets in a given configuration but are examples which should be possible to synthesize.

23984 (CONF-900364–1) **Effects of reactive elements on oxide scale deformation and cracking based on submicron indentation testing.** Tortorelli, P.F. (Oak Ridge National Lab., TN (USA)); Keiser, J.R.; Oliver, W.C.; Willson, K.R. Oak Ridge National Lab., TN (USA). [1990]. 13p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. From International conference on microscopy of oxidation; Cambridge (UK); 26-28 Mar 1990. Order Number DE90008900. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A method for characterizing the mechanical response of oxide scales by a depth-sensing submicron indentation technique is described for application to chromia-rich scales grown on a stainless steel. Results on room temperature micromechanical properties (elastic modulus, hardness, etc.) are presented to provide data for determining scale fracture criteria and to evaluate models in which reactive element additions to alloys modify the mechanical behavior of oxide scales and thereby improve scale adherence. Average values of elastic modulus for thin chromia-rich scales formed on 20–25–Nb steels was in good agreement with that for the bulk chromia. The addition of 0.13% Ce to the steel, which significantly improves scale adherence, did not affect the elastic modulus, hardness, strength, or plasticity of the oxide scale. These findings therefore did not support the subject models of scale adherence for cerium. However, the technique of depth-sensing submicron indentation testing appears to offer promise as a method of characterizing oxide scales. 22 refs., 4 figs., 2 tabs.

23985 (FNAL-TM–1587) **Development of intrinsic IPT scintillator.** Bross, A.D. Fermi National Accelerator Lab., Batavia, IL (USA). 31 Jul 1989. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-8811199–4: Workshop on scintillating fiber detector development for the SSC, Batavia, IL (USA), 14-16 Nov 1988). Order Number DE90007906. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We report on the development of a new polystyrene based plastic scintillator. Optical absorption, fluorescence and light output measurements are presented. Preliminary results of radiation damage effects are also given and compared to the effects on a commercial plastic scintillator, NE 110. 6 refs., 12 figs.

23986 (JINR–18-88-713) **Polypropilene nuclear track membranes - a new type of membranes for cleaning and analysis of agressive media.** Apel', P.Yu.; Shirkova, V.V.; Soboleva, T.I.; Kuznetsov, V.I.; Shestakov, V.D. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions. 1988. 4p. (In Russian). Order Number DE90621463. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The brief description of the polypropylene nuclear track membranes is given. The membranes are obtained from biaxially oriented polypropylene films 10μm thick by means of irradiation with accelerated heavy ions and following chemical etching. The data on pore shape, pore size dispersion, the permeability of membranes and on the content of impurities in membrane matrix are given. It is noted that the polypropylene membranes can be used

for cleaning and analysis of agressive chemical species. 9 refs.; 2 figs.

23987 (K/ETO–21) **Selected physical properties of n-perfluorobutane vapor.** Harkins, D.A. Oak Ridge Gaseous Diffusion Plant, TN (USA). Mar 1990. 8p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OT21400. Order Number DE90008732. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The evaluation of n-perfluorobutane (C_4F_{10}) as a possible alternative refrigerant for use at the gaseous diffusion plants requires computer modeling of its performance in existing systems. Certain physical properties are needed as input for this modeling. These properties must be approximated when data derived from experiments are unavailable. This report provides experimental data reported in the open literature for selected properties of n-perfluorobutane vapor. These values represent the best information that is currently available and should be used in the computer modeling of n-perfluorobutane performance. The specific properties reported herein are the pressure, density, heat capacity, thermal conductivity, and viscosity of saturated n-perfluorobutane vapor. The data are intended to apply over the likely temperature range of use. Several methods were used to obtain approximate property values. 9 refs., 4 tabs.

23988 (PB–90-858135/XAB) **Molybdenum disulfide lubrication. October 1976-January 1990 (Citations from the COMPENDEX data base). Report for October 1976-January 1990.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 115p. Available from NTISPC N01/MF N01.

Supersedes PB–85-868842.

This bibliography contains citations concerning molybdenum disulfide as a dry, solid lubricant. Molybdenum disulfide is combined with oils or greases, applied by coating processes, burnished into a surface or used as a filler in fabricating plastic and various materials. Topics discuss sliding friction, wear, material properties, and behavior of this lubricant. Various applications and environments are presented including bearings and gears. (This updated bibliography contains 259 citations, 135 of which are new entries to the previous edition.)

23989 (SAND–90-0648C) **Effect of solvent environments on the swelling behavior of elastomers commonly used in weapon components.** Green, P.F. Sandia National Labs., Albuquerque, NM (USA). [1990]. 3p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9004146–2: 16. DOE compatibility, aging and service life conference, Livermore, CA (USA), 24-26 Apr 1990). Order Number DE90008507. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The equilibrium swelling of a number of elastomeric seals, commonly used in weapon components, was determined after they were exposed to a saturated solvent environment. The dimensional stability of these elastomers in the solvents varied considerably. Reasons for this are discussed and a method by which one may estimate the degree of swelling that these elastomers will undergo in a solvent environment is presented. 5 refs.

23990 (SAND–90-0653C) **Aging and compatibility of TNF-doped mylar.** Arnold, C. Jr. Sandia National Labs., Albuquerque, NM (USA). [1990]. 3p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9004146–1: 16. DOE compatibility, aging and service life conference, Livermore, CA (USA), 24-26 Apr 1990). Order Number DE90008508. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

TNF-doped Mylar is a new radiation-hard dielectric that has recently been qualified as a viable substitute for Mylar in capacitors. The advantage of TNF-doped Mylar is that it satisfies both the nuclear safety and radiation hardness requirements of weapons. Mylar is not radiation-hard. Aging and compatibility studies were carried out to insure that (1) TNF does not diffuse from the film during fabrication of the capacitor or during storage; and (2) there are no compatibility problems with aluminum foil (the conductor) or Fluorinert (the secondary dielectric). Losses of TNF were barely detectable during the vacuum bakes used in fabricating capacitors or during accelerated aging tests carried out below T_g (70C) over a two year period in air. In other accelerated tests, no compatibility problems were detected with aluminum or Fluorinert. TNF-doped Mylar is now being used in the MC-4109 capacitor that was called out for use in SRAM II. We anticipate no age-related or compatibility-related problems with TNF-doped Mylar.

23991 (UCID–21955) **Direct sublimation of NaCl salt from carbon matrixes.** Zundelevich, Yury. Lawrence Livermore National Lab., CA (USA). Jan 1990. 65p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90007927. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report provides the theoretical groundwork for the design and operation of a system for sublimation of NaCl from carbon matrixes. The findings and recommendations summarized below are based on the results of computer modeling of momentum, heat and mass transport occurring in sublimator, condenser and the vacuum system that comprise complete sublimation system. Three major sublimation modes have been considered: in the absence of inert gas, in stagnant inert gas and in flowing inert gas. In the absence of inert gas sublimation is most rapid (typically under 2 days for the 'base' case of 12 bars with 12 μm pore size at 800°C in sublimator). At the beginning of the process (before pronounced porous layer is formed) the sublimation rate tends to be 'explosive' so that condenser could be easily overcome unless the sublimator temperature is gradually ramped over few hours to the final 800°C from a much lower level.

23992 (UCRL–15683) **Research and development of new ultraphosphate laser glasses: Final report.** Izumitani, T.; Toratani, H.; Matsukawa, T.; Kanamori, C.; Miyade, H. Lawrence Livermore National Lab., CA (USA). 30 Jan 1985. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008788. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Requirements for Zeus laser glass and HAP laser glass were small σ, low water, low concentration quenching and high mechanical and thermal strength in the former and high σ, low water, low concentration quenching and high mechanical, thermal shock resistance in the later. In order to get a high mechanical and thermal shock resistance, we introduced SiO_2 into phosphate glass, because SiO_2 gives a low expansion coefficient. In this report, we discuss the research and development of the laser glass. Chemical durability, water content, lasing properties, mechanical and thermo-mechanical properties, glass composition and glass structures are discussed.

23993 (UCRL-JC–103212) **New surface atomic structures for column V overlayers on the (110) surfaces of III-V compound semiconductors.** LaFemina, J.P. (Pacific Northwest Lab., Richland, WA (USA)); Duke, C.B.; Mailhiot, C. Lawrence Livermore National Lab., CA (USA). Feb 1990. 34p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900123–1: Physics and chemistry of semiconductor interfaces, Clearwater Beach, FL (USA), 31 Jan - 2 feb 1990). Order Number DE90009003. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Two new minimum-energy surface structures have been identified for p(1 x 1) overlayers of Sb on the (110) surface of III-V compound semiconductors using a tight-binding total-energy formalism previously developed for these systems. The first is the "commensurate chain" structure in which Sb zig-zag chains are commensurate with, and on top of, the Ga–As unreconstructed surface zig-zag chains. This structure differs from the previously found epitaxial-chain structure by virtue of the registry of the Sb chains "on top of" rather than "in between" the substrate Ga–As chains. Like the epitaxial chain structure, it is compatible with both scanning tunneling microscopy (STM) and photoemission data. The second is an "overlapping chain" structure in which the Sb chains are 180° out-of-phase with, and on top of, the Ga–As substrate chains. This structure is, however, incompatible with both low-energy-electron-diffraction and STM data for GaAs(110)-p(1 x 1)-Sb although it may be a possible structure for other systems. Computations for GaP(110)-p(1 x 1)-Sb and InSb(110)- p(1 x 1)-Sb reveal that the energy difference between the commensurate chain and traditional epitaxial structure is approximately constant

over this range of overlayer/substrate lattice mismatch. 16 ref., 8 figs., 3 tabs.

23994 Characterization of strained InGaAs single quantum well structures by ion beam methods. Yu, K.M. (Center for Advanced Materials, Materials and Chemical Sciences Division, Lawrence Berkeley Laboratory, 1 Cyclotron Road, Berkeley, California 94720 (USA)); Chan, K.T. *Applied Physics Letters (USA)*, 56(1): 45-47 (1 Jan 1990). DOE Contract AC03-76SF00098.

We have investigated strained InGaAs single quantum well structures using MeV ion beam methods. The structural properties of these structures, including composition and well size, have been studied. It has been found that the composition obtained by Rutherford backscattering spectrometry and particle-induced x-ray emission techniques agrees very well with that obtained by the ion channeling method.

23995 Hydrogen-accelerated thermal donor formation in Czochralski silicon. Stein, H.J. (Sandia National Laboratories, Albuquerque, New Mexico 87185 (USA)); Hahn, S.K. *Applied Physics Letters (USA)*, 56(1): 63-65 (1 Jan 1990). DOE Contract AC04-76DP00789.

Acceleration of thermal donor formation at 400 °C in Czochralski Si by a hydrogen plasma has been observed using low-temperature infrared absorption and spreading resistance probe measurements. The accelerated formation in as-grown Si is attributed to hydrogen diffusion and catalyzed conversion of electrically inactive nuclei to thermal donors. When the nuclei concentration is small such as in rapid thermal annealed Si, hydrogen interaction at SiO bonds is suggested as the rate-limiting step in thermal donor formation.

23996 Stability of coherently strained semiconductor superlattices. Dandrea, R.G. (Solar Energy Research Institute, Golden, Colorado 80401 (USA)); Bernard, J.E.; Wei, S.; Zunger, A. *Physical Review Letters (USA)*, 64(1): 36-39 (1 Jan 1990). DOE Contract AC02-77CH00178.

The excess energy of several III-V and II-VI strained-layer semiconductor superlattices $(AC)_p(BC)_p$ is studied as a function of the repeat period p and orientation G=[001], [110], [111], and [201], using first-principles calculations. We discover a number of universal features, including the predicted instability for nearly all p's and G's with respect to *bulk* disproportionation, the identification of chalcopyrite as a metastable ordered structure, and the stability of all thin *epitaxial* [110] and [201] and most common-anion [001] superlattices relative to coherent phase separation.

23997 Diffusion welding of silver interlayers coated onto base metals by planar-magnetron sputtering. Rosen, R.S. (Lawrence Livermore National Laboratory, Livermore, California 94550 (US)); Kassner, M.E. *Journal of Vacuum Science and Technology, A (Vacuum, Surfaces and Films) (USA)*, 8(1): 19-29 (Jan 1990). DOE Contract W-7405-ENG-48.

Silver has been coated onto various base metals by planar-magnetron (PM) sputtering to provide interlayers for diffusion welding. The vacuum-coating process consisted of two stages: (1) sputter etching of the base metals to remove surface oxide layers, followed by (2) vapor deposition of high-purity silver onto the clean surfaces. The silvers surfaces were diffusion welded at elevated pressure (207 MPa) and temperatures (483–673 K). The structures of the diffusion-welded-silver interlayer and the "as-deposited" coatings were determined using optical metallography and electron microscopy. The as-deposited structure consists of fine columnar grains ~0.25 μm in diameter, perpendicular to the base-metal surface with the axes of the columns oriented along the [111] crystallographic direction. These grains contain a high density of growth twins ~15 nm thick. The diffusion-welded-silver interlayer consists mostly of large recrystallized grains (>1 mm in diameter) containing a high density of annealing twins. However, a significant amount of the interlayer has not recrystallized. Additionally, the diffusion-welded-silver (silver-silver) interface consists of a high-angle grain boundary often formed between recrystallized and nonrecrystallized regions. For various base metals, the tensile strengths of diffusion-welded-silver joints fabricated using PM sputter deposition were found to be equal to or greater than previously reported strengths for those fabricated using brazing, electroplating, or other vapor-deposition methods. Tensile properties of diffusion-welded-silver joints fabricated using PM sputter-deposition were also found to be more reproducible than properties previously reported for joints fabricated using hot-hollow cathode (HHC) evaporation.

23998 Pressure-enhanced solid phase epitaxy of germanium. Lu, G.Q. (Division of Applied Sciences, Harvard University, Cambridge, Massachusetts 02138 (USA)); Nygren, E.; Aziz, M.J.; Turnbull, D.; White, C.W. *Applied Physics Letters (USA)*, 56(2): 137-139 (8 Jan 1990). DOE Contract AC05-84OR21400.

We have measured the effect of pressure on the solid phase epitaxial growth rate of Ge(100) into self-implanted amorphous Ge by using *in situ* time-resolved infrared interferometry in a high-temperature, high-pressure diamond anvil cell. In the temperature range 300–365 °C, a rate enhancement of more than a factor of 100 over that at ambient pressure has been observed due to hydrostatic pressures of up to 5.2 GPa (52 kbar). The pressure enhancement is characterized by a negative activation volume of -6.2 ± 0.6 cm^3/mol (-45% of the atomic volume), which is of the same sign but greater in magnitude than we found in Si. We conclude that the defects controlling the solid phase epitaxy of Ge cannot be vacancies in the crystal, that mechanisms based on other point defects migrating to the interface from either phase are unlikely, and that mechanisms based on point defects residing in the interface are plausible.

23999 Formation of silicon tips with <1 nm radius. Marcus, R.B. (Bellcore, 331 Newman Springs Road, Red Bank, New Jersey 07701 (USA)); Ravi, T.S.; Gmitter, T.; Chin, K.; Liu, D.; Orvis, W.J.; Ciarlo, D.R.; Hunt, C.E. *Applied Physics Letters (USA)*, 56(3): 236-238 (15 Jan 1990). DOE Contract W-7405-ENG-48.

Electron emitters in vacuum microelectronic devices need sharp tips in order to permit electron emission at moderate voltages. A method has been found for preparing uniform silicon tips with a radius of curvature less than 1 nm. These tips are formed by oxidation of 5-μm-high silicon cones through exploitation of a known oxidation inhibition of silicon at regions of high curvature.

24000 Doping and hydrogenation by ion implantation of glow discharge deposited amorphous silicon films. Galloni, R. (CNR-Instituto Lamel, via Castagnoli 1, 40126 Bologna, Italy (IT)); Tsuo, Y.S.; Baker, D.W.; Zignani, F. *Applied Physics Letters (USA)*, 56(3): 241-243 (15 Jan 1990).

We have studied the effects of ion implanting boron into glow discharge deposited hydrogenated amorphous silicon films (*a*-Si:H). Electrical activity more than two orders of magnitude higher than previously reported is measured in our samples. Implantations of Si ions are used to study the effect of post-annealing on the radiation damage. Hydrogen introduced by low-energy implantation and diffusion is found to completely recover electrical and optical characteristics in Si-implanted specimens even at the highest concentrations (10^{21}/cm^3), where annealing for 1 h at 260 °C was insufficient. Introduction of H in B-implanted samples was found to deactivate the boron, which can be reactivated by low-temperature annealing.

24001 Picosecond photoemission from microstructures. Srinivasan-Rao, T. (Brookhaven National Laboratory, Upton, NY 11973 (US)); Fischer, J.; Tsang, T. *AIP Conference Proceedings (American Institute of Physics) (USA)*, 193(1): 388-397 (15 Oct 1989). DOE Contract AC02-76CH00016. (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

In this paper, we present the results of our experiments to enhance the surface field on the photocathode with microstructures and to study the dependence of the efficiency and field enhancement on the surface structure. We have also included a brief summary of the results of our efficiency and high current density measurements. © 1989 American Institute of Physics

24002 Limitations of the integrated sub-band-gap absorption for determining the density of defects in amorphous silicon. Nobile, G. (Solar Energy Research Institute, Golden, Colorado 80401 (US)); McMahon, T.J. *Journal of Applied Physics (USA)*, 67(1): 578-580 (1 Jan 1990). DOE Contract AC02-83CH10093.

We discuss the procedure of calculating the density of states in the gap for amorphous silicon by integrating the excess sub-band-gap absorption. We show that in general the proportionality coefficient between the density of states and the integrated sub-band-gap absorption is not unique. The sum rule has been used improperly since integration of the excess subgap absorption is terminated either at a fixed energy or at an energy which does not include all optical transitions to the conduction band. We estimate the errors that can arise from this procedure.

24003 **Ordering in semiconductor alloys.** Bernard, J.E. (Solar Energy Research Institute, Golden, Colorado 80401 (US)); Dandrea, R.G.; Ferreira, L.G.; Froyen, S.; Wei, S.; Zunger, A. *Applied Physics Letters (USA),* 56(8): 731-733 (19 Feb 1990).

A thermodynamic first-principles theory of stability, including charge transfer, elastic forces, and atomic relaxations reveals the physical origins of stable and metastable ordering in bulk and epitaxial semiconductor alloys and superlattices.

24004 **The energy equation for freezing of biological tissue.** Rubinsky, B. (Department of Mechanical Engineering, University of California at Berkeley, Berkeley, CA 94720 (US)). *Journal of Heat Transfer (Transcations of the ASME (American Society of Mechanical Engineers), Series C) (USA),* 111(4): 988-997 (Nov 1989).

In the past, the process of freezing in biological tissue was modeled using the regular energy equation for a homogeneous compound. New experimental evidence shows that in tissue the water freezes separately in the vascular system and in the cells. The freezing process is affected by the water transport between the cells and the blood vessels. A new equation was developed to model the experimental results. In this work the general equation for freezing of biological tissue will be presented together with a linearized version of the new equation. A perturbation solution is obtained for the linearized equation to illustrate the effect of the water transport on the freezing process in tissue.

24005 **Low-temperature diamond growth in a microwave discharge.** Hsu, W.L. (Sandia National Laboratories, Livermore, California 94551-0969 (USA)); Tung, D.M.; Fuchs, E.A.; McCarty, K.F.; Joshi, A.; Nimmagadda, R. *Applied Physics Letters (USA),* 55(26): 2739-2741 (25 Dec 1989).

A new regime for plasma-assisted chemical vapor deposition (CVD) of diamond is reported in which high quality diamond films can be deposited on silicon with relatively high ratios of methane in hydrogen mixtures and at significantly lower substrate temperatures than previously reported. The deposition was achieved in a microwave plasma discharge with a feed gas consisting of a mixture of only methane and hydrogen. The surface temperature of a molybdenum sample, when exposed to the same plasma environment, was measured at 500 °C with an infrared scanning camera. This substrate temperature is substantially lower than the 700–1000 °C range generally regarded as the optimal regime for CVD diamond growth. Analysis by Raman spectroscopy showed that films deposited with a 2% methane in hydrogen mixture produced a near graphite-free diamond film at our reported low-temperature regime, while deposition at 1000 °C resulted in films with a much higher graphitic content.

24006 **Structure of crystals of hard colloidal spheres.** Pusey, P.N. (Royal Signals and Radar Establishment, Malvern, WR14 3PS, United Kingsom (GB)— Department of Applied Physics, Royal Melbourne Institute of Technology, Melbourne, Victoria, Australia— School of Chemistry, Bristol University, Bristol, BS8 1TS, U *Physical Review Letters (USA),* 63(25): 2753-2756 (18 Dec 1989).

We report light-scattering measurements of powder diffraction patterns of crystals of essentially hard colloidal spheres. These are consistent with structures formed by stacking close-packed planes of particles in a sequence of permitted lateral positions, *A,B,C,* which shows a high degree of randomness. Crystals grown slowly, while still containing many stacking faults, show a tendency towards face-centered-cubic packing: possible explanations for this observation are discussed.

24007 **Symmetry-specific densities of rovibrational energy levels for nonseparable systems.** Toselli, B.M. (Univ. of Michigan, Ann Arbor (USA)); Barker, J.R. *Journal of Physical Chemistry (USA),* 93(18): 6578-6581 (7 Sep 1989).

Symmetry-specific densities of states, $N_i(E)$ = (i = symmetry species) for nonseparable vibrational and rovibrational coupled systems, are calculated from spectroscopic data by a relatively simple and efficient Monte Carlo technique, which employs Tisza's rules for the symmetry assignments of individual states. Results are presented for NO_2 and CH_2O. The calculations show the effects of the intermode couplings on $N_i(E)$ and the rate of convergence of $N_i(E)$ toward the group theoretical regular representation at high energy.

24008 **Photochemistry of 3,4,9,10-perylenetetracarboxylic dianhydride dyes. 4. Spectroscopic and redox properties of oxidized and reduced forms of the bis(2,5-di-tert-butylphenyl)imide derivative.** Ford, W.E. (Univ. of Notre Dame, IN (USA)); Hiratsuka, H.; Kamat, P.V. *Journal of Physical Chemistry (USA),* 93(18): 6692-6696 (7 Sep 1989).

Four oxidation states of N,N′-bis(2,5-di-tert-butylphenyl)-3,4,9,10-perylenebis(dicarboximide) (DBPI) are characterized electrochemically and spectroscopically. The oxidation of DBPI to its radical cation ($DBPI^{\bullet+}$) is irreversible and occurs at an electrode potential of about +2.2 V vs SCE. The reductions of DBPI to the radical anion ($DBPI^{\bullet-}$) and $BDPI^{\bullet+}$ to the dianion ($DBPI^{2-}$) are reversible with reduction potentials of -0.73 and -0.96 V vs SCE, respectively. The radical anion is stable with respect to disproportionation. All three electron-transfer products of DBPI, which were produced either by radiolysis or by chemical reduction, have intense ($\epsilon \approx 10^5\ M^{-1}\ cm^{-1}$) absorption bands in the visible or near-infrared region, with maxima near 600 nm ($DBPI^{\bullet+}$), 700 nm ($DBPI^{\bullet+}$), or 545 nm ($DBPI^{2-}$). The kinetic parameters of pulse radiolytic oxidation and reduction of DBPI are determined, and the redox potentials of the first excited singlet and triplet states of DBPI are estimated.

24009 **Si(111) 2×1 surface core-level shifts investigated by use of Ge overlayer.** Woicik, J.C. (Stanford Synchrotron Radiation Laboratory, Stanford, California 94305 (US)); Pianetta, P.; Kendelewicz, T. *Physical Review, B: Condensed Matter (USA),* 40(18): 12463-12467 (15 Dec 1989). DOE Contract AC03-82ER13000.

The Si 2*p* core level and the valence band from the clean Si(111) 2×1 surface both before and after the room-temperature deposition of Ge have been studied with high-resolution photoemission spectroscopy. We find that the deposition of 5 A of Ge onto the Si(111) 2×1 surface fully quenches the surface-shifted components of the Si 2*p* spectra. By obtaining the Si 2*p* core-level line shape from the Ge-covered surface, we ascertain that the surface-sensitive Si(111) 2×1 2*p* core level consists of at least four components, one of which was previously unresolved. These components are attributed to different atoms in the 2×1 π-bonded chain structure.

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Refer also to citation(s) 23831, 23899, 23903, 23904, 23905, 23980, 24007, 24008, 24100, 24111, 24879

24010 (INIS-SU–147/A) **8. All-union conference on the methods of preparation and analysis of high purity substances. Part 3: Abstracts.** AN SSSR, Gorki (USSR). Inst. Khimii; Gor'kovskij Gosudarstvennyj Univ., Gorki (USSR). 1988. 232p. (In Russian). (CONF-8805350–: 8. All-Union conference on the methods of preparation and analysis of high-purity substances, Gor'kij (USSR), 10 May 1988). Order Number DE90706030. Available from NTIS (US Sales Only), PC A11/MF A01 - OSTI; INIS.

Individual papers in scope for the data base are processed separately. (DLC)

24011 **Study of the influence of axial dispersion on the band profile in nonlinear chromatography using the Lax-Wendroff method.** Lin, Bingchang (Univ. of Tennessee, Knoxville (USA)); Ma, Zidu; Guiochon, G. *Separation Science and Technology (USA),* 24(11): 809-829 (Sep 1989).

A comparison is made between the results obtained with the Lax-Wendroff and the characteristic algorithms for the integration of the system of partial differential equations of chromatography. The influence of the diffusion coefficient on the elution profiles is determined in the linear and the nonlinear cases by using 2 different sets of boundary conditions, and the results are compared. A new phenomenon is predicted in the nonlinear case, which has no equivalent in the linear case; the regressive behavior of the retention time of the band maximum when the diffusion coefficient increases from values near 0 to very high values. On the other hand, it is observed that the elution profiles predicted by the Lax-Wendroff method are relatively independent of the values of the space and time increment chosen for the calculation, the opposite of what has been reported with the characteristic algorithm. This will provide a suitable procedure for the numerical calculation of solutions of kinetic models.

24012 Novel surface-enhanced fluorescence detection of polynuclear aromatic hydrocarbons separated by paper chromatography. Chen, Y.F. (Oak Ridge National Lab., TN (USA)); Johnson, R.W.; Vo-Dinh, T. *Analytical Letters (USA),* 22(8): 2011-2019 (Jul 1989). DOE Contract AC05-84OR21400;AC05-76OR00033.

Amorphous fumed silica was used to enhance the fluorescence signal of a mixture of polynuclear aromatic (PNA) compounds separated by paper chromatography. Benzo[a]pyrene-r-7,t-8,9,10-tetrahydrotetrol (BPT) and benzo[a]pyrene (BaP) were well resolved by paper chromatography using a 50% (v/v) mixture of acetonitrile and 5 mM pH 7.0 phosphate buffer as the chromatographic solvent. A 200-400% enhancement of the fluorescence intensity was observed when fumed silica was applied to the chromatographic paper prior to separation. The results demonstrate that paper chromatography using fumed silica treated paper offers a simple, cost-effective method to improve sensitivity for fluorescence detection of PNA components in environmental samples relative to untreated paper.

24013 Chemically induced dynamic nuclear polarization in systems containing large hyperfine coupling constants. Roth, H.D. (AT and T Bell Labs., Murray Hill, NJ (USA)); Hutton, R.S.; Hwang, Kuochu; Turro, N.J.; Welsh, K.M. *Journal of Physical Chemistry (USA),* 93(15): 5697-5701 (27 Jul 1989).

Nuclear spin polarization effects induced in radical pairs with one or more strong (^{13}C) hyperfine coupling constants have been evaluated. The pairs were generated by photoinduced α-cleavage or hydrogen abstraction reactions of carbonyl compounds. Several examples illustrate how changes in the magnetic field strength (H_0) and the g-factor difference (Δg) affect the general appearance of the resulting CIDNP multiplets. The results bear out an earlier caveat concerning the qualitative interpretation of CIDNP effects observed for multiplets.

24014 Five stable points on the N_6 energy hypersurface: Structures, energies, frequencies, and chemical shifts. Engelke, R. (Los Alamos National Lab., NM (USA)). *Journal of Physical Chemistry (USA),* 93(15): 5722-5727 (27 Jul 1989).

Five stationary points on the N_6 energy hypersurface have been located by use of ab initio self-consistent field (SCF) methods. These five points correspond to the N_6 analogues of the $(CH)_6$ structures: (a) benzene (1), (b) Dewar benzene (2), (c) benzvalene (3), (d) triprismane (4), and (e) trans-3,3′-bicyclopropenyl (5). The points of the energy hypersurface are calculated in the restricted Hartree-Fock approximation, using 4-31G and 4-31G* basis sets. At the stationary points, vibrational frequencies have also been calculated at the RHF/4-31G and RHF/4-31G* levels. Within the RHF/4-31G* model, all the structures are stable. For trans-3,3′-bicyclopropenyl, no corresponding stationary point is found with the RHF/4-31G model. The five structures are higher in energy than three N_2 molecules by (1) 243, (2) 289, (3) 303, (4) 382, and (5) 286 kcal/mol with the RHF/4-31G* model. The effect of electron correlation on the energies is examined by use of the MP2-FC/4-31G*//RHF/4-31G* and MP2=FC/4-31G//RHF/4-31G models. In most cases, the inclusion of correlation stabilizes the structures to dissociation into three N_2 molecules by 30-50 kcal/mol (relative to the mean field results). The lowest (nontorsional) RHF/4-31G* vibrational frequency for 2-5 is significantly larger than that of 1, indicating that the geometries of 2-5 are more rigidly defined by the energy hypersurface than is 1. Nitrogen chemical shifts are also presented; these were calculated at the RHF/4-31G level using gauge-invariant atomic orbitals and SCF perturbation theory. Most calculations were also performed on diatomic nitrogen (N_2), diimide (N_2H_2), and hydrazine (N_2H_4); these results are used as an aid in the interpretation of the N_6 results.

24015 Photochemical synthesis of disilane from silane with infrared laser radiation. Zavelovich, J. (Amoco Technology Co., Naperville, IL (USA)); Lyman, J.L. *Journal of Physical Chemistry (USA),* 93(15): 5740-5745 (27 Jul 1989).

The authors report the clean and efficient conversion of silane to disilane by CO_2 laser irradiation. The direct irradiation of pure silane at high pressures (from 75 to 1,700 Torr) converts silane to disilane with high selectivity and with efficient use of the absorbed laser radiation. Hydrogen is the only other major volatile product, and the production of solid products is minimal. The proposed mechanism of the photochemical reaction includes (1) collisionally enhanced absorption of the laser radiation by silane, (2) collisional deexcitation of the vibrationally excited silane, (3) concurrent decomposition to SiH_2 and H_2, (4) production of vibrationally excited disilane by SiH_2 insertion into a silane Si-H bond, (5) collisional quenching of the excited disilane, and (6) rapid cooling of the irradiated gas by thermal expansion. They support the proposed mechanism by additional experiments and model calculations.

24016 Effect of iridium(IV) oxides on the decay of zinc tetrakis(N-methylpyridinium-4-yl)porphyrin π-radical cation in the presence of poly(styrenesulfonate). Nahor, G.S. (National Institute of Standards and Technology, Gaithersburg, MD (USA)). *Journal of Physical Chemistry (USA),* 93(15): 5808-5813 (27 Jul 1989).

The π-radical cation of zinc tetrakis(N-methylpyridinium-4-yl)porphyrin($ZnTMPyP^{5+}$) has been produced by pulse radiolysis and its decay reactions have been followed in the presence of oxoiridium(IV) hydrate species and a negatively charged polyelectrolyte, poly(styrenesulfonate) (PSS). The iridium oxide species were produced from hexachloroiridate, and the nature of the product strongly depended on the pH during preparation. A hexahydroxoiridate species that was produced at high pH was found to be very reactive, and its reactions account for most decay processes observed. γ-Radiolysis experiments suggest that this decay involves oxidation of the iridium species in a catalytic process. PSS-stabilized IrO_x hydrosols did not react with the radical cation fast enough to compete with its disproportionation, although such hydrosols were highly reactive when stabilized with neutral or positively charged polymers. The lack of reactivity is attributed to the low mobility of the positively charged porphyrin in the domain of the negatively charged polyelectrolyte as well as to the absence of interpolymer processes. However, under γ-radiolysis conditions, a redox reaction between the hydrosols and the radical becomes feasible.

24017 Sensitized and heavy atom induced production of acenaphthylene triplet: A laser flash photolysis study. Samanta, A. (Univ. of Notre Dame, IN (USA)); Fessenden, R.W. *Journal of Physical Chemistry (USA),* 93(15): 5823-5827 (27 Jul 1989).

The triplet state of acenaphthylene has been examined by nanosecond laser flash photolysis using sensitization and heavy atom perturbation techniques. Although acenaphthylene does not form any observable triplet upon direct flash excitation, a transient with microsecond lifetime (λ_{max} = 315 nm) is observable when a solution of the sample is excited by sensitizers (benzophenone, thioxanthone, benzil). This transient is ascribed to the triplet of acenaphthylene on the basis of its quenching behavior toward oxygen, ferrocene, azulene, and β-carotene. Quantitative data concerning the triplet-triplet absorption and quenching constants are presented. The triplet energy is estimated to lie between 46 and 47 kcal/mol. The triplet can also be produced by direct excitation in solvents containing heavy atoms (ethyl bromide, ethyl iodide). The triplet yield is found to increase with an increase of the amount of the heavy atom containing solvent. No saturation limit is obtained. These facts together with the effect of heavy atoms on the T_1 →

S_0 process allow the differing behavior of ethyl bromide and ethyl iodide on the photodimerization process of acenaphthylene to be explained. Triplet-state parameters (extinction coefficient and triplet yield) have been estimated in these solvents by the energy-transfer technique and actinometry.

24018 Wavelength dependence of the photochemistry of hydrogen iodide-acetylene complexes in solid krypton. Abrash, S.A. (Lawrence Berkeley Lab., CA (USA)); Pimentel, G.C. *Journal of Physical Chemistry (USA),* 93(15): 5834-5839 (27 Jul 1989). DOE Contract AC03-76SF00098.

Hydrogen iodide-acetylene complexes in a krypton matrix at 12 K have been photolyzed at fixed wavelengths in the range 222-308 nm. Products are identified with infrared spectroscopy. With deuterium substitutions (HI x C_2D_2 and DI/HI/C_2H_2), 3 product channels are identified leading to isotopic exchange, formation of vinyl iodide, and formation of iodoacetylene. At wavelengths longer than 300 nm, only iodoacetylene is formed whereas at shorter wavelengths, isotopic exchange occurs (e.g., HI x C_2D_2 → DI x C_2HD), vinyl iodide is formed, and some iodoacetylene is formed. Because the T-shaped geometry of the HI x C_2H_2 complex is well established, it is possible to interpret these results by recognizing that the photolysis involves 2 molecules in proximity, a supramolecule. As the hydrogen atom leaves the iodine atom, it forms initially C_2H_3. Correlating the energy levels along this initial reaction coordinate indicates the initial photolytic reaction surfaces, and Franck-Condon arguments explain the wavelength dependence of the product distribution. This supramolecule analysis provides a prototype analysis for other examples of photolysis of bound and geometrically constrained complexes.

24019 Nonequilibrium processes in polymers undergoing interchange reactions. 1. Relaxation rates. Kondepudi, D.K. (Wake Forest Univ., Winston-Salem, NC (USA)); Pojman, J.A.; Mansour, M.M. *Journal of Physical Chemistry (USA),* 93(15): 5931-5937 (27 Jul 1989). DOE Contract AS05-81ER10947.

Relaxation processes due to interchange reactions in polymer systems are analyzed by use of the analogy with the Boltzmann equation for a gas of hard spheres. The linear rate of relaxation of a perturbation in the n-mer concentration is obtained. By use of Monte Carlo simulation, the range of validity of the linear approximation is shown to be fairly large.

24020 Multiple four-coordinate forms in a nickel hydrocorphinate related to cofactor F_{430} of methylreductase. Shelnutt, J.A. (Sandia National Labs., Albuquerque, NM (USA)). *Journal of Physical Chemistry (USA),* 93(17): 6283-6290 (24 Aug 1989). DOE Contract AC04-76DP00789.

Four- and 6-coordinate forms of a nickel(II) hydrocorphinate model of cofactor F_{430} of the methyl-coenzyme M methylreductase were investigated by using resonance Raman spectroscopy. The 6-coordinate complexes have Raman spectra showing only a single species at room temperature and at 77 K in frozen solutions. The 6-coordinate complexes are characterized by the two highest frequency, strong lines in the 1550-1560- and 1620-1630-cm^{-1} regions. There is a variation in the frequencies of these two marker lines with the particular axial ligand, but the separation of the lines remains relatively constant at 67-74 cm^{-1}. The separation of these two lines is an indicator of the nickel coordination number for the hydrocorphinate. The separation for a 5-coordinate complex is 81 cm^{-1}, and for the major 4-coordinate form the separation is about 93 cm^{-1}. Raman spectra of 4-coordinate nickel hydrocorphinates show evidence of multiple species both at room temperature and at 77 K. Besides the previously identified 4-coordinate form, we have now identified two other forms. One of the newly identified species is detected in room temperature Raman spectra taken with preresonance excitation and is observed also in frozen solutions. The other new 4-coordinate form is positively detected only in frozen samples. The new room temperature form has a red-shifted absorption spectrum based on resonance enhancement of its Raman scattering with excitation to the red of the absorption maximum. This red shift is consistent with the observed 20-nm red shift in the absorbance maximum upon freezing at 77 K, under which conditions the new species dominate. A structural interpretation of the 4-coordinate forms is proposed based on molecular mechanics calculations for the nickel hydrocorphinate enantiomers.

24021 In situ time-resolved x-ray absorption near edge structure study of the nickel oxide electrode. McBreen, J. (Brookhaven National Lab., Upton, NY (USA)); O'Grady, W.E.; Tourillon, G.; Dartyge, E.; Fontaine, A.; Pandya, K.I. *Journal of Physical Chemistry (USA),* 93(17): 6308-6311 (24 Aug 1989). DOE Contract AC02-76CH00016.

In situ time-resolved X-ray absorption spectroscopy was coupled with cyclic voltammetry to investigate X-ray absorption near edge structures (XANES) at the Ni K-edge of both α-$Ni(OH)_2$ and β-$Ni(OH)_2$ in KOH electrolytes. β-$Ni(OH)_2$ electrodes with and without $Co(OH)_2$ additions were also studied. The XANES results for the three different electrodes exhibit (i) a continuous shift of the edge absorption to higher energies during the oxidation process in agreement with the general overall electrochemical reaction Ni^{2+} → Ni^{2+} and (ii) a modification of the edge features that is related to changes in the Ni-O local environment. Initially, there is a regular octahedral coordination where each Ni atom is surrounded by six O atoms in the discharged state. Upon oxidation the material evolves to a distorted octahedral structure. This is associated with a continuous decrease of the white line intensity of the XANES spectra. For α-$Ni(OH)_2$ these processes are completely reversible when the potential is swept in the cathodic direction. In the oxidized state, some differences were observed in the electrodes with $Co(OH)_2$ additions. There was a splitting of the XANES maximum and a shift of the edge to higher energy. This is due to a more complete oxidation of $Ni(OH)_2$. The cyclic voltammograms for the β-$Ni(OH)_2$ electrodes gave two well-defined reduction current peaks, as opposed to one for α-$Ni(OH)_2$. After the first reduction peak the electrode contains charged and discharged material. No evidence for a new species was detected.

24022 Experimental investigation of donor-acceptor electron transfer and back transfer in solid solutions. Dorfman, R.C. (Stanford Univ., CA (USA)); Lin, Y.; Fayer, M.D. *Journal of Physical Chemistry (USA),* 93(17): 6388-6396 (24 Aug 1989). DOE Contract FG03-84ER13251.

Electron transfer from an optically excited donor (rubrene) to randomly distributed acceptors (duroquinone) followed by electron back transfer in a rigid solution (sucrose octaacetate) has been studied experimentally. The forward electron-transfer process was observed by time-dependent fluorescence quenching measurements, while the electron back transfer from the radical anion to the radical cation was monitored by use of the picosecond transient grating technique. A statistical mechanics theory is used to describe the time-dependent dynamics of the system and to extract the forward- and back-transfer parameters from the data. The theory includes donor-acceptor and acceptor-acceptor excluded volume. It is found that the inclusion of excluded volume is necessary to obtain accurate transfer parameters. These parameters enable a detailed description of the electron transfer and recombination dynamics to be given. The agreement between theory and experiment is excellent. A variety of time-dependent properties of the system are calculated. These include the time-dependent ion populations and the probability that the ith acceptor is an ion as a function of time and distance. In addition, $\langle R(t) \rangle$ and $\langle \tau(t) \rangle$, which are the average ion separation as a function of time and the average ion existence time as a function of ion separation, respectively, are calculated.

24023 Relativity and chemical bonding. Balasubramanian, K. (Arizona State Univ., Tempe (USA)). *Journal of Physical Chemistry (USA),* 93(18): 6585-6596 (7 Sep 1989). DOE Contract FG02-86ER13558.

The importance of relativistic effects on chemical and spectroscopic properties of molecules containing very heavy atoms is considered. Recent developments that combine large scale ab initio multiconfiguration self-consistent field/configuration interaction (MCSCF/CI) methods with relativistic configuration interaction (RCI) methods including spin-orbit coupling effects are reviewed. The impact of relativistic effects on the electronic properties, geometries, dipole moments, and other properties of heavy-transition-metal clusters and their reactivities with H_2 are discussed. The periodic trends in properties and bonding within various groups are considered.

24024 Infrared spectroscopic studies of supercritical fluid solutions. Blitz, J.P. (Pacific Northwest Lab., Richland, WA (USA)); Yonker, C.R.; Smith, R.D. *Journal of Physical Chemistry (USA)*, 93(18): 6661-6665 (7 Sep 1989). DOE Contract AC06-76RL01830.

Near- and mid-infrared spectroscopic studies of supercritical carbon dioxide and binary supercritical fluid solutions of carbon dioxide/water, argon/water, krypton/water, and xenon/water as a function of fluid density are reported. The intermolecular interactions for supercritical carbon dioxide and solvent environments indicated by the IR studies are compared to results obtained from UV-visible solvatochromic studies with supercritical carbon dioxide. Infrared shifts observed in the binary fluid mixtures with water are discussed in terms of the Onsager electrostatic theory. The results demonstrate that while solute shifts induced by noble gas solvents can be described by a simple model based upon dielectric contributions, this model inadequately explains results for water/carbon dioxide mixtures. Further information can be obtained by monitoring the rotational freedom of the solute and directly probing the solvent as a function of density by IR spectroscopy.

24025 Effect of mass-transfer kinetics on the elution of a binary mixture in nonlinear liquid chromatography. Golshan-Shirazi, S. (Oak Ridge National Lab., TN (USA)); Lin, B.; Guiochon, G. *Journal of Physical Chemistry (USA)*, 93(18): 6871-6880 (7 Sep 1989).

A procedure for calculating numerical solutions of the nonlinear, nonequilibrium model of chromatography for a two-component mixture is described. Solutions are presented and discussed for a series of numerical values corresponding to a wide range of mass-transfer kinetics for either component. When the mass-transfer kinetics is not very slow, the band profiles are controlled by the thermodynamic effects and the solutions are identical with those obtained by solution of the corresponding semiideal model. When the kinetics becomes slow, the nonlinear thermodynamic effects decrease and vanish. The retention time of the maximum of the band profile first increases, then decreases, and eventually a bimodal band appears, with the second maximum eluted with non-retained compounds. When the mass-transfer kinetics of the two components are very different, elution profiles are complex. The coupling effect between the two bands disappears rapidly if the component which has the larger concentration is the one with the very slow kinetics. As the opposite of the semiideal model, previously discussed, this model permits an accurate prediction of the elution profiles of the components of a mixture when their mass-transfer coefficients are different.

24026 Substituent effects on the binding of phenols to cyclodextrins in aqueous solution. Bertrand, G.L. (Univ. of Missouri, Rolla (USA)); Faulkner, J.R. Jr.; Han, S.M.; Armstrong, D.W. *Journal of Physical Chemistry (USA)*, 93(18): 6863-6867 (7 Sep 1989). DOE Contract FG02-88ER13819.

Equilibrium constants and standard enthalpies have been measures calorimetrically for the formation of complexes of α- and β-cyclodextrins with substituted phenols in aqueous solutions at 298.15 K. The study includes variation of the size and shape of the phencl, the size and degree of methylation of the cyclodextrin, and the effects of pH and ionic strength. Substituent effects were measured for p-chloro-, p-bromo-, p-methyl-, p-hydroxy-, p-nitro- and m-nitrophenols. The effects of ionization were studied with m- and p-nitrophenolate ions. The effects of methyl substitutions of β-cyclodextrin were investigated with nitrophenol and nitrophenolate ions complexing with heptakis (2,6-di-O-methyl)-β-cyclodextrin and heptakis (2,3,6-tri-O-methyl)-β-cyclodextrin. All of the effects studied show a substantial amount of entropic-enthalpic compensation, such that free energy effects are relatively small in comparison to enthalpic and/or entropic effects, but there was no simple relationship between the standard enthalpies and entropies of complex formation. However, a linear relationship was observed between the enthalpy and entropy for the transfer of substituted phenols from the complex with α-cyclodextrin to the complex with β-cyclodextrin. This relationship was independent of pH and ionic strength. In general, complex formation of a substituted phenol with α-cyclodextrin is more exothermic than with β-cyclodextrin, but the entropy of complex formation is also more negative.

24027 Thermodynamics for the clustering of ammonia onto Pb^+ in the gas phase. Gleim, K.L. (Pennsylvania State Univ., University Park (USA)); Guo, B.C.; Keesee, R.G.; Castleman, A.W. Jr. *Journal of Physical Chemistry (USA)*, 93(18): 6805-6809 (7 Sep 1989).

Equilibrium constants together with the enthalpy, entropy, and Gibbs free energy changes were determined for the gas-phase stepwise addition reactions of up to four ammonia molecules onto the Pb^+ ion. Standard enthalpy changes of -28.3, -19.2, -13.0, and -10.7 kcal/mol and entropy changes of -23.3, -27.3, -22.0, and -24.8 cal/K · mol were measured for the first, second, third, and fourth steps of the clustering, respectively. These results, along with earlier ones for the clustering of ammonia onto Li^+, Na^+, K^+, and Rb^+, provide evidence concerning the structure and types of bonding in metal ion-ammonia clusters. Since the binding in Pb^+NH_3 and $Pb^+(NH_3)_2$ is much stronger than that expected by electrostatic calculation, partial covalent interaction of Pb^+ with NH_3 is likely in these two clusters. Theoretical calculations were also carried out with the Sakur-Tetrode equation to determine the contributions of the translational, rotational, and vibrational components to the entropy change for each of the above clustering reactions.

24028 Molecular and ionic phases of solid nitrosyl chloride at low temperature. Killough, P.M. (Los Alamos National Lab., NM (USA)); Swanson, B.I.; Agnew, S.F. *Journal of Physical Chemistry (USA)*, 93(23): 7953-7956 (16 Nov 1989).

The discovery of two solid phases of nitrosyl chloride is reported. ONCl-II is stable in the range 85-203 K and is composed of dimers of the ONCl molecule. The absence of the NO stretch in this phase from 136 to 203 K is caused by dephasing due to thermal occupation of a torsional mode of the dimer, which appears at 117 cm^{-1} and is not observed over the same temperature range. Within the molecular phase, dramatic softening of both the N-Cl stretch and ONCl bend occurs as temperature is reduced. ONCl-I is stable over the range 13-85 K and represents an ionic phase of ONCl with at least 2 NO^+Cl^-/primitive unit. The transition from ONCl-II to ONCl-I is first order with substantial hysteresis and is accompanied by the coalescence of intra- and intermolecular N-Cl modes.

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Refer also to citation(s) 23354, 23540, 23633, 24013, 24014, 24020, 24024, 24060, 24287, 24313, 24857, 25156, 25230

24029 (ANL/PPRNT–90-206) **Application of ^{252}CF-PDMS in the analysis of cyclodextrins and their derivatives.** Hunt, J.E.; Wagner, A.M.; Michalski, T.J. Argonne National Lab., IL (USA). [1990]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90008709. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

^{252}Cf-plasma desorption mass spectrometry (PDMS) of α, β, and γ cyclodextrins (1, 2, and 3) is presented. Cationized molecular ions are observed for all compounds studied. Characteristic patterns of fragmentation involving the loss of four or more glycosyl units appear in the spectra. This method is also applied to the analysis of hexakis (2,6-di-O-methyl)-α-, 4, heptakis (2,6-di-O-methyl)-β-, 5, and mono (6-OTs)-β-, 6, cyclodextrins. Fragmentation provides information on the molecular structure of these thermally labile cyclodextrins. 27 refs., 4 figs., 1 tab.

24030 (CEA-CONF–9895) **Trace determination of Pu by LIF in an inductively coupled plasma.** Mauchien, P. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (FR). Dept. de Chimie Appliquee et d'Etudes Analytiques); Briand, A.; Moulin, C.; Aubanel, R.; Blanchard, J.M.; Schott, R.; Sourouille, M. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Chimie Appliquee et d'Etudes Analytiques. 1989. 12p. (CONF-890617–: 2. Karlsruhe international conference on analytical chemistry in nuclear technology, Karlsruhe (Germany, F.R.), 5-9 Jun 1989). Order Number DE90762046. Available from NTIS (US Sales Only), PC A03/MF A01.

Inductively Coupled Plasma/Emission Spectrometry (ICP/ES) technique is largely used in the nuclear industry as an elementary analytical technique. Nevertheless, when the sample to analyse presents elements with a lot of emission spectral lines, spectral

interferences lead to limited sensitivity. This is the case for Pu determination in presence of large U concentration. In pure aqueous solution, the limit of detection (LOD) for Pu is 10 μg/1. In presence of U, the LOD is determined by a ratio U/Pu = 1000. Pulsed Laser Induced Fluorescence (LIF) spectrometry is known to be a very selective technique when associated with an Inductively Coupled Plasma source. The absolute sensitivity is better by 2 or 3 orders of magnitude; its principle is based on selective excitation of the ionic species in the plasma followed by fluorescence radiation detection of these species; this radiation being practically free from spectral interferences, it is possible to improve the relative LOD. In this presentation, experimental results performed at Cogema/ Marcoule laboratory are presented. After the experimental set-up description, first results of LIF are shown: - very good selectivity is effectively obtained, - a series of analytical results obtained with excitation scanning from the visible to the U.V. show that sensitivity of LIF technique is strictly related to the spectroscopic scheme.

24031 (CEA-CONF–9896) **Laser-induced time-resolved spectrofluorometry and thermal lensing: applications in the nuclear industry.** Decambox, P.; Delorme, N.; Mauchien, P.; Moulin, C. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Chimie Appliquee et d'Etudes Analytiques. 1989. 17p. (CONF-890617–: 2. Karlsruhe international conference on analytical chemistry in nuclear technology, Karlsruhe (Germany, F.R.), 5-9 Jun 1989). Order Number DE90762056. Available from NTIS (US Sales Only), PC A03/MF A01.

Sensitive spectroscopic methods for the determination of actinides and lanthanides in various media are required in the nuclear industry. Laser-Induced Time-Resolved Spectrofluorometry (LITRS) for several actinides and lanthanides at very low levels and thermal lensing (TL) for oxidation state characterization allow these determinations. The set-up of LITRS is presented. Spectra, limit of detections and lifetimes obtained for U, Cm, Am, Eu, Gd, Tb, Dy, Ce, Sm, Tm are shown. Detection limit as low as 5.10^{-12} M can be achieved. Examples of matrices encountered for the determination of uranium are given as well as comparison with mass spectrometry and alpha counting. The set-up of TL and performances obtained on plutonium as well as future developments are presented.

24032 (CEA-CONF–9897) **Analytical methods and problems for the diamides type of extractants.** Cuillerdier, C.; Nigond, L.; Musikas, C.; Vitart, H.; Hoel, P. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Genie Radioactif. 1989. 9p. (CONF-890617–: 2. Karlsruhe international conference on analytical chemistry in nuclear technology, Karlsruhe (Germany, F.R.), 5-9 Jun 1989). Order Number DE90762047. Available from NTIS (US Sales Only), PC A02/MF A01.

Diamides of carboxylic acids and especially malonamides are able to extract alpha emitters (including trivalent ions such as Am and Cm) contained in the wastes solutions of the nuclear industry. As they are completely incinerable and easy to purify, they could be an alternative to the mixture CMPO-TBP which is used in the TRUEX process. A large oxyalkyl radical enhances the distribution coefficients of americium in nitric acid sufficiently to permit the decontamination of wastes solutions in a classical mixers-settlers battery. Now researches are pursued with the aim of optimizing the formula of extractant, the influence of the structure of the extractant on its basicity and stability under radiolysis and hydrolysis is investigated. Analytical methods (potentiometry and NMR of C^{13}) have been developed for solvent titration and to evaluate the percentage of degradation and to identify some of the degradation products.

24033 (CEA-CONF–9898) **Analytical studies of chemical and physical properties of concentrated plutonium solutions in nitric acid medium and their variations during long time storage.** Cuillerdier, C.; Cossonnet, C.; Pelras, M. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Genie Radioactif. 1989. 9p. (CONF-890617–: 2. Karlsruhe international conference on analytical chemistry in nuclear technology, Karlsruhe (Germany, F.R.), 5-9 Jun 1989). Order Number DE90762048. Available from NTIS (US Sales Only), PC A02/MF A01.

The behaviour of concentrated solutions of PuIV (250 and 500g/ l) in HNO_3 5M during long time storage is investigated. Metals are tested for their resistance to corrosion (Zr, Ti, steels: ZZCND17-12, ZZCND18-10, Uranus S). Physical and chemical properties (density, viscosity, radiolytic gas evolution) of the solutions are studied.

24034 (COGEMA-CONF–89-1) **A new analysis technique for microsamples.** Boyer, R.; Journoux, J.P.; Duval, C. Compagnie Generale des Matieres Nucleaires (COGEMA), 26 - Pierrelatte (France). 1989. 23p. (CONF-8903203–: Meeting on techniques and standards for destructive analysis, Salamenca (Spain), 7-9 Mar 1989). Order Number DE90762049. Available from NTIS (US Sales Only), PC A03/MF A01.

For many decades, isotopic analysis of Uranium or Plutonium has been performed by mass spectrometry. The most recent analytical techniques, using the counting method or a plasma torch combined with a mass spectrometer (ICP.MS) have not yet to reach a greater degree of precision than the older methods in this field. The two means of ionization for isotopic analysis - by electronic bombardment of atoms or molecules (source of gas ions) and - by thermal effect (thermoionic source) are compared revealing some inconsistency between the quantity of sample necessary for analysis and the luminosity. In fact, the quantity of sample necessary for the gas source mass spectrometer is 10 to 20 times greater than that for the thermoionization spectrometer, while the sample consumption is between 10^5 to 10^6 times greater. This proves that almost the entire sample is not necessary for the measurement; it is only required because of the system of introduction for the gas spectrometer. The new analysis technique referred to as "Microfluorination" corrects this anomaly and exploits the advantages of the electron bombardment method of ionization.

24035 (CSIR-SP-SFIS–5, pp. 57-61) **Geochronology.** Retief, E.A. (Council for Scientific and Industrial Research, Pretoria (South Africa). National Physical Research Lab.). Council for Scientific and Industrial Research, Pretoria (South Africa). National Physical Research Lab. 1986. In *Annual report July 1985 - June 1986*. Available from the National Physical Research Laboratory, PO Box 395, Pretoria, 0001, South Africa. Available from the National Physical Research Laboratory, PO Box 395, Pretoria, 0001, South Africa.

U-Pb, Pb-Pb, Rb-Sr and Sm-Nd methods were used to investigate the isotopic compositions and geological ages of a variety of rock types found in South Africa and South West Africa/Namibia. Conventional isotope analytical methods on zircon and single crystal studies on an ion microprobe were conducted to find a reliable age for the Makwassie quartz porphyry of the Ventersdorp Supergroup. The agreement between these results suggest that the U-Pb zircon age of 2699 $\pm$ 16 Ma is the age of extrusion of the Makwassie quartz porphyry. The implications of these results are that the minimum age thus established for the sediments of the Witwatersrand Supergroup is higher than has hitherto been accepted. Geochronological investigations of the Sinclair Sequence in South West Africa/Namibia provided information on the timing of crustal formation in this area.The Sinclair Sequence forms a chronostratigraphic marker between the older Namaqua-Natal Mobile Belt and the younger Damara Orogen. An isotope geochemical study of rocks from south-central Natal was also undertaken.Above average concentrations of uranium were found in this area. In Southern Natal U has been preferentially enriched in lithologies formed in the period 1050-950 Ma age. A pre-Karoo carbonatite complex discovered east of Bothaville was dated by the Rb-Sr isotope method and shown to be younger than the Ventersdorp Supergroup and isotopically similar to otherintrusives constituting the Pilansberg Alkaline Province. 5 refs., 1 fig.

24036 (DOE/OR/21600–T35) **The determination of carbon in uranium metal using the LECO CS-244 carbon and sulfur determination, Model 784-000.** Westinghouse Materials Co. of Ohio, Cincinnati, OH (USA). Feed Materials Production Center. 22 Aug 1989. 25p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-86OR21600. Order Number DE90008859. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This method is designed for the determination of micro amounts of carbon in uranium metal. Training under the direction of a qualified analyst and an understanding of the instrument's instruction manual are required prior to use of the CS-244. The range of analysis for this procedure is 0.00 – 1.75% carbon for a 2 gram

sample. The time it takes to analyze one sample is 1 minute or less. Carbon present in a sample is oxidized to carbon monoxide and carbon dioxide. The oxidation is performed by heating the sample to its melting point in a high frequency induction furnace in a stream of pure oxygen. Granulated tungsten is used as an accelerator. The oxidation of carbon monoxide to carbon dioxide is catalyzed by platinized silica gel. A cellulose fiber trap removes any oxides of sulfur which form during the combustion. Magnesium perchlorate removes any water formed. After the interferences are removed the oxygen carries the carbon dioxide through an infrared (IR) absorption cell. The carbon content is computed by microprocessor integration of the IR CO_2 absorbance peak.

24037 (IAEA-TECDOC–537, pp. 57-67) **Prompt gamma neutron activation analysis of hard coal, raw lignite and raw glass mixture.** Herzog, W. (Staatliches Materialpruefungsamt Nordrhein-Westfalen, Dortmund (Germany, F.R.)). International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8901184–: Advisory group on prompt gamma neutron activation analysis in borehole logging and industrial process control, Vienna (Austria), 30 Jan - 3 feb 1989). In *Prompt gamma neutron activation analysis in borehole logging and industrial process control: Report of an advisory group meeting held in Vienna, 30 January - 3 February 1989.* Order Number DE90621001. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

Prompt gamma neutron activation analysis (PGNAA) has proved to be a useful technique for the multielement characterisation of bulk material such as coal, limestone, minerals and ores. The use of isotopic neutron sources like Cf-252 enables the construction of small irradiation facilities for on-line analysis. Feasibility studies carried out by the Staatliches Material-pruefungsamt on PGNAA on-line analysers for hard coal, lignite and raw glass mixtures using Cf-252 are described in this paper. (author). 4 refs, 6 figs, 1 tab.

24038 (IAEA-TECDOC–537, pp. 69-84) **MOCA: An advanced Monte Carlo code using a micro-computer for spectral responses of neutron-gamma logging tools.** Pinault, J.L. (Bureau de Recherches Geologiques et Minieres (BRGM), 45 - Orleans (France)); Gateau, C. International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8901184–: Advisory group on prompt gamma neutron activation analysis in borehole logging and industrial process control, Vienna (Austria), 30 Jan - 3 feb 1989). In *Prompt gamma neutron activation analysis in borehole logging and industrial process control: Report of an advisory group meeting held in Vienna, 30 January - 3 February 1989.* Order Number DE90621001. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

During the last consultants meeting organized by the International Atomic Energy Agency we presented briefly the development of B.R.G.M.'s technology in boreholes logging based on nuclear geophysics. Recently the "in situ" analysis group has been involved in research to improve the MOCA MONTE CARLO code to obtain directly the complete pulse-height spectral response of neutron-gamma method for borehole configuration. Some comparisons with experiments are achieved and they showed a very good agreement. Such models would be extremely useful in probe design and in tool calibration too. (author). 14 refs, 6 figs, 4 tabs.

24039 (IAEA-TECDOC–537, pp. 85-103) **Quantitative and qualitative applications of the neutron-gamma borehole logging.** Charbucinski, J. (Commonwealth Scientific and Industrial Research Organization, Port Melbourne (Australia). Div. of Geomechanics); Eisler, P.L.; Borsaru, M.; Aylmer, J.A. International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8901184–: Advisory group on prompt gamma neutron activation analysis in borehole logging and industrial process control, Vienna (Austria), 30 Jan - 3 feb 1989). In *Prompt gamma neutron activation analysis in borehole logging and industrial process control: Report of an advisory group meeting held in Vienna, 30 January - 3 February 1989.* Order Number DE90621001. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

Two examples of neutron-gamma borehole logging application are described. In the quantitative application of the PGNAA technique, research was carried out both in the laboratory and at a mine to establish a suitable borehole logging technology for Mn-grade predictions. As an example of qualitative application of PGNAA, use of this method has been demonstrated for determination of lithology. (author). 4 refs, 10 figs, 7 tabs.

24040 (IAEA-TECDOC–537, pp. 105-134) **Elemental concentrations in igneous rocks determined by high-resolution borehole gamma-ray spectrometry and applications to petrochemical problems.** Mikesell, J.L. (Geological Survey, Reston, VA (USA)); Senftle, F.E.; Anderson, R.N.; Greenberg, M. International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8901184–: Advisory group on prompt gamma neutron activation analysis in borehole logging and industrial process control, Vienna (Austria), 30 Jan - 3 feb 1989). In *Prompt gamma neutron activation analysis in borehole logging and industrial process control: Report of an advisory group meeting held in Vienna, 30 January - 3 February 1989.* Order Number DE90621001. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

A high-resolution gamma-ray spectrometric method using a ^{252}Cf neutron source is employed to obtain a partial elemental analysis of an igneous rock down a borehole without taking a core sample. The concentrations of the elements Si, Al, Fe, Ca, Na, K, Ti, Mn, Cr, V, Ni, and B are measured in terms of their capture gamma-ray response, using silicon as a calibration standard. Magnesium, which is not measured directly, is calculated as a residual. The method was tested experimentally in the Palisade Diabase, but is applicable to any acid or basic igneous rock. The data are presented as elemental borehole logs which can be determined in real time. Computer programs use the elemental composition data to compute petrochemical information, which is displayed in real time in the form of borehole logs. In this way it is possible to make borehole logs showing changes in alteration, mafic and felsic indices, and normative mineral composition. Such borehole logs can be a powerful tool for the classification and comparison of rocks. (author). 32 refs, 8 figs, 4 tabs.

24041 (KCP–613-4202) **The purity of electronic grade 1,1,2-trichlorotrifluoroethane by gas chromatography: Final report.** Dubiel, S.V. Allied-Signal Aerospace Co., Kansas City, MO (USA). Kansas City Div. Mar 1990. 22p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00613. Order Number DE90008161. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A gas chromatography (GC) method was developed to determine the purity of electronic grade 1,1,2-trichlorotrifluoroethane (TCTFE) for use in cleaning electronic components. High purity TCTFE is required to assure that the impurities would not inhibit or increase solvency characteristics. The low ppm chlorinated hydrocarbon (CHC) and chlorofluorocarbon (CFC) impurities were separated on a GC packed column containing a polydimethylsiloxane stationary phase and helium as the carrier gas. Flame ionization detected the resolved impurities as they eluted from the column. The standard addition method and computer intergration was used for quantitation. The concentration of known and unknown impurities were added together and subtracted from 100% to obtain the percent purity of TCTFE. The relative standard deviation (RSD) for ten replicate peak area determinations varied from 2 to 4% for most of the known impurities. The RSD for calculating ten replicate concentrations for two known impurities in the same sample was 2.8% for the 2.4 ppm (w/w) impurity and 1.3% for the 12.4 ppm impurity. 2 refs., 1 fig., 6 tabs.

24042 (MINTEK-M–395) **The separation of trace elements in high-purity rhodium and iridium materials.** Robert, R.V.D (Council for Mineral Technology, Randburg (South Africa). Analytical Science Div.); Graham, S.M. Council for Mineral Technology, Randburg (South Africa). Analytical Science Div. 13 Nov 1989. 9p. Available from Mintek, Private Bag X3015, Randburg, 2125, South Africa. Available from Mintek, Private Bag X3015, Randburg, 2125, South Africa.

In the determination of trace levels of impurities in high-purity rhodium and iridium materials by atomic-absorption spectrophotometry, significant interference is encountered from the high concentration level of the major element, despite the use of releasing agents. This report describes the experimental work carried out, firstly, on the extent of the interference and, secondly, on methods of separation that will permit interference-free measurement of the impurities. Chromatographic seperation of the major

element from the other noble metals is achieved by use of cellulose powder as the stationary phase and a mixture of tributyl phosphate and toluene as the mobile phase. Base-metal impurities are separated by means of the cation exchanger Dowex 50W-X8. Although the determination of rhodium, iridium, and ruthenium as impurities is not as good as that of platinum and palladium, the method does afford a means of analysing the ammonium chloride salts of rhodium and iridium at the 99,99 per cent purity level. With furnace atomization, the lower limits of determination range from 0,5 μg/g for palladium to 5,0 μg/g for iridium, with precisions varying between 3 and 23 per cent. 6 refs., 2 figs., 4 tabs.

24043 (RR–54) **Strontium isotopic evidence for preserved density stratification from the main zone of the Bushveld Complex: implications for possible undiscovered platinum and gold mineralization.** Sharpe, M.R. (Institute for Geological Research on the Bushveld Complex, Univ. of Pretoria, Pretoria (South Africa)). Pretoria Univ. (South Africa). Mar 1985. 23p. Available from the Registrar, University of Pretoria, Pretoria, 0002, South Africa. Available from the Registrar, University of Pretoria, Pretoria, 0002, South Africa.

The Rustenburg Layered Suite of the Bushveld Complex is the product of fractional crystallization of two magma series and their mixtures in a density-stratified magma chamber. The series, called U and A, have compositions sufficiently different that the chronology of magma intrusion to the Complex can be tracked by means of detailed chemical analyses and $^{87}Sr/^{86}Sr$ initial ratios (R_0) of the layered cumulates. The bulk of the lower 3 km of the main zone is isotopically distinct from the underlying critical zone, the rocks that lie above the 'pyroxenite marker' and the chilled gabbroic marginal rocks that occur along its basal contact. It is interpreted as a fossilized, 2 km thick layer of high R_0 (>0,7085) A liquid that intruded into the stratified liquid pile dominated by A + U mixtures (R_0=0,7065) at a level consistent with its density. Minor mixing with underlying trapped liquid gave rise to the Merensky Reef; more substantial mixing with the superelevated magma column produced the 'pyroxenite marker' as shown by substantial isotopic reversals. The magma column, enriched in precious metals, thus formed the parental material for the upper zone (R_0=0,7073), in which minor precious metal mineralization has already been found. Other, as yet undiscovered ore deposits can thus be postulated. (author) 21 refs., 5 figs., 2 tabs.

24044 A warning concerning the use of glass capillary arrays in gas dosing: Potential chemical reactions. Leavitt, P.K. (Ames Laboratory and Department of Chemistry, Iowa State University, Ames, Iowa 50011 (US)); Thiel, P.A. *Journal of Vacuum Science and Technology, A (Vacuum, Surfaces and Films) (USA)*, 8(1): 148-149 (Jan 1990). DOE Contract W-7405-ENG-82.

We have encountered complications using a glass, capillary-array gas doser in our laboratory. In this note, we discuss the possibility that chemical reactions occur on the glass surface.

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Refer also to citation(s) 23348, 23724, 23899, 23917, 23944, 23976, 23980, 24011, 24012, 24014, 24016, 24019, 24022, 24025, 24026, 24027, 24028, 24109, 24131, 24198, 24199, 24879

24045 (ANL/PPRNT–90-200) **Fourier Transform EPR [Electron Paramagnetic Resonance] of chemical reactions.** Massoth, R.J.; Bowman, M.K. Argonne National Lab., IL (USA). [1990]. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90008703. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Transient free radicals formed by laser photolysis have been measured in solution by Fourier Transform Electron Paramagnetic Resonance. The high resolution spectra positively identify the initial free radicals formed from the quenching of triplet duroquinone by triethylamine in solution. The spectra were used to follow the kinetics of the free radicals from less than 10^{-8} s to 10^{-2} s. The kinetics are well described by a model based on simple chemical reactions and triplet mechanism chemically-induced dynamic electron polarization. Numerical estimates are obtained for ratios of the rates of various reaction steps. 5 refs., 2 figs.

24046 (BARC–1460) **Studies on separation of boron isotopes by ion exchange.** D'souza, A.B. (Bhabha Atomic Research Centre, Bombay (India). Chemical Engineering Div.); Sonwalkar, A.S. Bhabha Atomic Research Centre, Bombay (India). 1989. 8p. Order Number DE90621237. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Studies have been carried out for the enrichment of boron isotopes by the ion exchange method using various anion exchange resins available. The elementary separation factors and heights equivalent of theoretical plate were measured at different concentrations and flow rates. A number of experiments were performed to study the displacement of borate band on ion exchange columns. The problem of CO_2 evolution during displacement was also studied and a solution was found. (author). 9 refs.

24047 (CONF-900395–1) **Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference: Summary of DOE-BES research projects.** USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. 217p. Sponsored by U.S. DOE Energy Research. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. Order Number DE90008091. Available from NTIS, PC A10/MF A01; OSTI; INIS; GPO Dep.

Research programs on catalysis and surface chemistry are presented. A total of fifty-seven topics are included. Areas of research include heterogeneous catalysis; catalysis in hydrogenation, desulfurization, gasification, and redox reactions; studies of surface properties and surface active sites; catalyst supports; chemical activation, deactivation; selectivity, chemical preparation; molecular structure studies; sorption and dissociation. Individual projects are processed separately for the data bases. (CBS)

24048 (DOE/ER/13108–T5) **Pulse radiolytic studies of inter- and intramolecular electron transfer processes: Progress report.** Neta, P.; Lias, S. National Inst. of Standards and Technology, Gaithersburg, MD (USA). Chemical Kinetics Div. 17 Jan 1989. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AI05-83ER13108. Order Number DE90008697. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Electron transfer processes have been studied by the pulse radiolysis technique using spectrophotometric detection. In general, these studies include examination of the mechanisms, rate constants, and equilibrium constants of electron transfer reactions in a variety of chemical systems such as organic radicals and radical ions, inorganic radicals, and metalloporphyrins, both in aqueous and in non-aqueous solutions. Highlights of our results during the past three years are summarized below under the following sections: metalloporphyrins and colloidal catalysts, peroxyl radicals, inorganic radicals, and other topics.

24049 (DOE/ER/13150–T3) **Laser studies of chemical dynamics at the gas-solid interface: Progress report, January 1987–Jun 1989.** Cavanagh, R.R.; King, D.S. National Inst. of Standards and Technology (NML), Gaithersburg, MD (USA). Center for Atomic, Molecular and Optical Physics. [1990]. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AI05-84ER13150. Order Number DE90008698. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The DOE funded research program "Laser Studies of Chemical Dynamics at the Gas-Solid Interface" has taken a detailed, microscopic view of molecules desorbed from surfaces in order to gain an understanding of energy flow and interaction potentials and how these control chemical reactivity at interfaces. Successful completion of these experiments required technical expertise both in surface science and laser-based molecular dynamics, a collaborative situation that exists in the NIST center for Atomic, Molecular and Optical Physics. During the three year period covered by this progress report, our goal was to use state-resolved techniques to examine a single chemisorption system in detail, and to observe how changes in the interaction potential or method of surface excitation are manifest in the desorption dynamics. The system chosen was NO/Pt(111). Studies were undertaken in which the effects on the NO-Pt interaction potential of coadsorbates–both weakly (CO)

and strongly (NH_3) interacting– could be examined. In addition, attempts were to be made to study non- equilibrium dynamics by using pulsed laser heating. 18 refs.

24050 (DOE/ER/13296–6) **The transformation of organic amines by transition metal cluster compounds: Progress report, 1989–1990.** Adams, R.D. South Carolina Univ., Columbia, SC (USA). Dept. of Chemistry. Feb 1990. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract FG09-84ER13296. Order Number DE90008834. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Research continued on transition element complexes. The following chemical reactions are described: sulfido osmium carbonyl clusters containing secondary aminocarbene ligands and catalytic tertiary amine metathesis; aminocarbene ligands formed by the hydrogenation of ynamine ligands; aminocarbene ligands formed by the reaction of $Os_3(CO)_{10}(H)_2$ with ynamines; reactions of MeC_2NMe_2 with $Os_4(CO)_{12}(S)$; reactions of MeC_2NMe_2 with the molecules $M_3(CO)_{10}(S)$, (M=Fe, Ru, Os); and studies of the reactions of alkynes with iminium ligands. 12 refs.

24051 (DOE/ER/13603–T3) **Study of intermediates from transition metal excited-state electron-transfer reactions: Progress report, January 1, 1989–March 15, 1990.** Hoffman, M.Z. Boston Univ., MA (USA). Dept. of Chemistry. 15 Mar 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13603. Order Number DE90009027. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This is the progress report for the period of January 1989 to March 1990 and contains brief summaries for the undertaken projects. The projects discussed are: cage escape yields in the quenching of Ru(II) photosensitizers, characterization of one-electron reduced Ru(II) complexes; application of Marcus theory to electron-transfer processes in Ru(II) complexes; synthesis and characterization of new Ru(II) photosensitizers; NMR study of ion-pairing in aqueous solutions containing $Ru(bpy)_3^{2+}$; and reductive quenching of Ru(II) and Cr(III) complexes. (JDL)

24052 (DOE/ER/13935–1) **Synthesis and chemistry of cationic d^0 metal alkyl complexes: Annual report, January 1988–December 31, 1989.** Jordan, R.F. Iowa Univ., Iowa City, IA (USA). [1990]. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER13935. Order Number DE90008985. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The objective of this project is to synthesize cationic, d^0 organometallic complexes and to study their role in catalytic olefin polymerization and oxidation chemistry, and in C-H activation chemistry. Attention is focused on complexes which incorporate highly unsaturated Lewis acidic metal centers and reactive alkyl or oxo ligands. These features combine to promote coordination and subsequent reaction of olefins and of ligand C-H bonds. In the first budget period of this project significant progress has been made in the synthesis of highly unsaturated cationic Zr(IV) alkyls, cationic Ti and Hf alkyls, and Re oxo alkyls, and a very general approach to productive ligand C-H bond activation chemistry has been explored.

24053 (HCR-CDM–09) **Determination of rate ion exchange of zeolites modified by actinides and lanthanides I. Determination of selectivity coefficients of Na^+ ion sensitive electrode in presence of series of cations.** Achache, M.; Azzouz, A.; Nibou, D. Haut Commissariat a la Recherche, Algiers (Algeria). Centre de Developpement des Materiaux. Sep 1989. 10p. (In French). Order Number DE90621091. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

In order to determine the ion-exchange rate of zeolites modified by some rare earths and actinides elements, an extended selective ion potentiometry was used; the purpose of the present paper consists in natrium determination in presence of Co, Sr, La, Ce, Tl, Pb and uranyl ions using a Na electrode and an Ag/AgCl reference electrode. The results obtained show that this technique can be easily applied to Co, Sr, La, Ce, Tl and Pb ions determination for which the selectivity constant presents values between 5.50 and 85. The uranyl ion seems to be the most difficult to determine and presents a selectivity constant of about 1000. On the other hand, there is a certain correlation between the molecular weight and the selectivity constant value, and this correlation seems to confirm the applicability of the model used.

24054 (INIS-SU–145/A) **4. All-union conference. The problems of solvation and complexing in solutions. part 2: Summary of reports.** AN SSSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Khimicheskoj Termodinamike; Vsesoyuznoe Khimicheskoe Obshchestvo, Moscow (USSR); Vsesoyuznoe Khimicheskoe Obshchestvo, Moscow (USSR). Sektisiya Fizicheskoj i Kolloidnoj Khimii (USSR). 1989. 340p. (In Russian). (CONF-8906266–: 4. All-Union conference on the problems of solvation and complexing in solutions, Ivanovo (USSR), 6-8 Jun 1989). Order Number DE90706029. Available from NTIS (US Sales Only), PC A15/MF A01 - OSTI; INIS.

Individual papers in scope for the data base are processed separately.

24055 (LBL–28104) **Polyatomic reaction dynamics.** Ruf, B.A. Lawrence Berkeley Lab., CA (USA). Nov 1989. 145p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90008668. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

This work presents five theoretical methods of describing chemical reactions such as hydrogen transfer in polyatomic systems, where it is necessary to describe how energy is transferred between vibrational modes. These methods combine a minimal amount of ab initio computation with other theoretical tools. The first technique is accurately describing two important degrees of freedom by generating a 2-dimensional potential surface that is a function of these coordinates and coupling the latter to vibrational modes. The second technique is the formation of a simple cartesian Hamiltonian without any kinetic coupling. Another method for generating an expression without kinetic coupling is presented. This third method rigorously transforms the kinetic energy coupling terms of the linear reference Hamiltonian into potential energy coupling terms. As an alternative to using only ab initio data as input into the potential, a fourth method is described which uses empirical information as well as ab initio data. Finally, the last approach presented uses Monte Carlo path integral techniques with density matrices to abstract tunneling splittings of a hydrogen transfer process. 31 refs.

24056 **Tunable far infrared laser spectroscopy of van der Waals bonds: The intermolecular stretching vibration and effective radial potentials for Ar–H_2O.** Cohen, R.C. (Department of Chemistry and Materials and Chemicals Sciences Division, University of California and Lawrence Berkeley Laboratory, Berkeley, California 94720 (US)); Busarow, K.L.; Lee, Y.T.; Saykally, R.J. *Journal of Chemical Physics (USA),* 92(1): 169-177 (1 Jan 1990). DOE Contract AC03-76SF00098.

Measurements of the fundamental van der Waals stretching vibration $\Sigma(0_{00},\nu_s=1) \leftarrow \Sigma(0_{00},\nu_s=0)$ of Ar–H_2O [ν_0=907 322.08(94) MHz] and a transition from the lowest excited internal rotor state $\Sigma(1_{01},\nu_s=0)$ to the $\Sigma(1_{01},\nu_s=1)$ level [ν_0=1019 239.4(1.0) MHz] are presented. A simultaneous rotational analysis of the new stretching data with the internal rotor bands observed by us previously [J. Chem. Phys. 89, 4494 (1988)], including the effects of Coriolis interactions, provides experimental evidence for the new assignment of the internal rotor transitions suggested by Hutson in the accompanying paper. Fits to the rotational term values for the $\nu_s=0$ states are used to derive effective radial potential energy surfaces for each of the Σ internal rotor states. The results show the well depth (153.4 cm^{-1}) of the effective radial potential for the $\Sigma(1_{01},\nu_s=0)$ level to be approximately 25 cm^{-1} deeper than that for the $\Sigma(0_{00},\nu_s=0)$ ground state of the complex, indicating that the former is stabilized considerably more by the anisotropic intermolecular potential energy surface than is the ground state.

24057 **The isotope exchange reaction of fast hydrogen atoms with deuterated alkynes and alkenes.** Johnston, G.W. (Department of Chemistry, Columbia University, New York, New York 10027 (USA)); Satyapal, S.; Bersohn, R.; Katz, B. *Journal of Chemical Physics (USA),* 92(1): 206-212 (1 Jan 1990).

The exchange reaction H(1 eV)+RD→RH+D, where RD was deuterated acetylene, methylacetylene, ethylene, and propylene was studied by laser induced fluorescence detection of the hydrogen and deuterium atoms. The reaction cross sections were

1.69±0.22, 0.50±0.15, 1.85±0.20, and 1.10±0.14 A^2, respectively. The fraction of the incident relative kinetic energy released as translation was 0.42, 0.34, 0.40, and 0.34. That the addition of a methyl group only slightly reduces the energy released as translation is regarded as proof that the reaction at this energy does not involve a long lived intermediate complex, but is a direct localized displacement. Further confirmation comes from the observation that the velocity of the D atom product of $H+C_2D_2$ is correlated with the velocity of the H atom reactant.

24058 The translational energy dependence of the $F+C_2H_4 \rightarrow H+C_2H_3F$ reaction cross section near threshold. Robinson, G.N. (Materials and Chemical Sciences Division, Lawrence Berkeley Laboratory, Berkeley, CA (USA)); Continetti, R.E.; Lee, Y.T. *Journal of Chemical Physics (USA)*, 92(1): 275-284 (1 Jan 1990). DOE Contract AC03-76SF00098.

We have carried out crossed molecular beam studies of the substitution reaction $F+C_2H_4 \rightarrow H+C_2H_3F$ in the collision energy range 0.8–2.5 kcal/mol using a velocity selected F atom beam. The relative substitution cross section is found to decrease with increasing collision energy indicating that if there is a potential energy barrier to F atom addition to C_2H_4 it is much less than 0.8 kcal/mol and that the transition state for addition occurs early along the reaction coordinate. These results agree well with *ab initio* calculations. Although the product translational energy distributions are similar to those obtained from earlier work at higher collision energies, the C_2H_3F angular distributions suggest that a wider range of reactant approach geometries lead to products at lower energies.

24059 Substituent effects on ferrocenes in aluminum chloride-butylpyridinium chloride molten-salt mixtures. Edgecombe, A.L. (Gould Research Center, Rolling Meadows, IL (USA)); Fowler, J.S.; Gibbard, H.F.; Slocum, D.W.; Phillips, J. *Organometallics (USA)*, 9(2): 307-311 (Feb 1990).

The visible absorption spectra and reduction potentials of 11 ferrocenes containing electron-withdrawing substituents were determined in an N-n-butylpyridinium chloride-aluminum chloride molten salt. When the substituent(s) on the cyclopentadienyl ring(s) of ferrocene were varied, the reduction potential was caused to range over 1.25 V, and the wavelength for maximum absorption of visible light was varied by nearly 200 nm. These changes are greater than have been observed for similar ferrocenes in other nonaqueous solvents. Evidence is presented for specific interactions of particular ferrocenes with the molten salt.

24060 Synthesis and characterization of manganese and rhenium metallacycles. Gibson, D.H. (Univ. of Louisville, KY (USA)); Owens, K.; Mandal, S.K.; Sattich, W.E.; Richardson, J.F. *Organometallics (USA)*, 9(2): 424-431 (Feb 1990).

Reactions of manganese or rhenium formyl complexes bearing phosphine or phosphite ligands with protonic acids have been utilized in developing synthetic routes to new five- and six-membered metallacyclic compounds, $Mn(CO)_4[P(Ph)_2(o\text{-}C_6H_4CH_2)]$ and $M(CO)_3(L)$ $[P(OPh)_2(o\text{-}OC_6H_4CH_2)]$ (M = Mn, L = CO or $P(OPh)_3$; M = Re, L = $P(OPh)_3$). The synthetic route makes use of the ability of formyl complexes to transfer hydride in the presence of a protonic acid without transferring it to the acid. Two of the manganese compounds have been characterized by X-ray crystallography: (i) crystal data for $Mn\text{-}(CO)_4[P(Ph)_2(o\text{-}C_6H_4CH_2)]$, a = 13.519 (3) Å, b = 8.295 (2) Å, c = 18.199 (3) Å, β = 90.82 (1)°, Z = 4, d_c = 1.44 g cm^{-3}, space group $P2_1/c$, and R = 0.029; (ii) crystal data for $Mn(CO)_3[P(OPh)_3]$ $[P(OPh)_2(o\text{-}OC_6H_4CH_2)]$, a = 15.977 (8) Å, b = 26.554 (10) Å, c = 8.523 (6) Å, β = 87.12 (5)°, Z = 4, d_c = 1.42 g cm^{-3}, space group $P2_1/n$, and R = 0.039. The IR and ^1H and ^{13}C NMR spectral properties of all four metallacycles are reported.

24061 Reactions of iminium ligands with alkynes. Addition of $HC{\equiv}CCO_2Me$ to $Os_3(CO)_{10}(\mu\text{-}H_2CNMe_2)(\mu\text{-}H)$. Adams, R.D. (Univ. of South Carolina, Columbia (USA)); Babin, J.E.; Wolfe, T.A. *Organometallics (USA)*, 9(2): 440-446 (Feb 1990).

The reaction of $Os_3(CO)_{10}(\mu\text{-}H_2CNMe_2)(\mu\text{-}H)$ (1) with $HC{\equiv}CCO_2Me$ has yielded three new products, $Os_3(CO)_8(\mu\text{-}CNMe_2)$ $[\mu_3\text{-}CH_2C(CO_2Me)C(CO_2Me)CH]$ (3, 7%°), $Os_3(CO)_9[\mu_3\text{-}Me_2NCCC(H)(CO_2Me)](\mu\text{-}H)$ (4, 20%), and $Os_3(CO)_9[\mu_3\text{-}H_2CNMe_2CH_2CCO_2Me]$ (5, 6%). Compounds 3-5 were characterized by IR, ^1H NMR, and single-crystal X-ray diffraction analyses. Crystal data for 3: space group, $P2_1/n$, a = 9.998 (3) Å, b = 14.229 (4), c = 17.926 (3) Å, β = 104.67 (2)°, R = 0.028 for 2616 reflections. Crystal data for 4: space group, P1, a = 10.623 (2) Å, b = 12.877 (2) Å, c = 8.531 (2) Å, α = 102.18 (1)°, β = 102.14 (2)°, γ = 85.85 (1)°, R = 0.025 for 2508 reflections. Crystal data for 5: space group $P2_1/c$, a = 8.778 (4) Å, b = 15.836 (3) Å, c = 16.029 (4) Å, β = 105.61 (3)°, R = 0.052 for 2907 reflections.

24062 Potential-energy surfaces for Pt_2+H and Pt+H interactions. Balasubramanian, K. (Department of Chemistry, Arizona State University, Tempe, Arizona 85287-1604 (USA)); Feng, P.Y. *Journal of Chemical Physics (USA)*, 92(1): 541-550 (1 Jan 1990).

Potential-energy surfaces for ten electronic states of Pt_2H as a function of Pt_2–H distance are constructed using the complete active space multiconfiguration self-consistent field followed by multireference singles plus doubles configuration interactions which included up to 407 000 configurations. In addition, the spin-orbit effects were included through the relativistic configuration-interaction method. The potential-energy curves of low-lying electronic states of PtH and spectroscopic constants of 11 states of PtH are also computed using the same method. The experimental A'–X_2 spectroscopic bands of PtH are reassigned to the $^2\Sigma^+$(II)–1/2(I) transition. A tentative reassignment of the observed B'–X_1 system is also suggested. The ground state of Pt_2H is found to be of E(I) symmetry when spin-orbit effects are incorporated with a bridged structure [R_e(Pt–Pt)=2.46 A, R_e(Pt–H)=1.684 A]. A very low-lying excited state E(II) (T_e=0.14 eV) was found for Pt_2H. The $D_e(Pt_2H)$=59 kcal/mol compared to the D_e(PtH)=72 kcal/mol, indicating lower stability of the Pt_2H bridge compared to PtH diatomic. Some of the low-lying electronic states of PtH, especially 3/2 states, exhibit avoided crossings.

24063 A composition density functional theory for mixtures based upon an infinitely polydisperse reference. I. Formalism and theory. Kofke, D.A. (Department of Chemical Engineering, University of Pennsylvania, Philadelphia, Pennsylvania 19104-6393 (US)); Glandt, E.D. *Journal of Chemical Physics (USA)*, 92(1): 658-666 (1 Jan 1990).

A general, statistical mechanical theory which relates the properties of mixtures of different compositions is presented. It is developed within a semigrand canonical framework, and thus the mixtures are formally described by species chemical potential differences, rather than directly by composition. The introduction of a set of *n*-particle composition distribution functions leads to a composition-space superposition approximation (CSSA), which forms the only approximate part of the treatment. A functional expansion of the canonical partition function in terms of the composition density is used to develop systematic corrections to the CSSA. Infinitely polydisperse mixtures [D. A. Kofke and E. D. Glandt, J. Chem. Phys. **90**, 439 (1989)] are shown to be the composition-space analogs of homogeneous pure fluids, and the scaling properties of these mixtures make them ideal as a reference in the theory. The required input is the density-invariant composition of the infinitely polydisperse reference. The validity of the method is demonstrated on hard-particle fluids using accurate equations of state from the literature. Although based on a polydisperse reference, the treatment is equally applicable to discrete, i.e., conventional mixtures. In its most stringent test—the prediction of *pure-fluid* properties—the theory based on an infinitely polydisperse reference displays quantitative agreement with known behavior.

24064 Determination of excess Gibbs free energy from computer simulation by the single charging-integral approach. I. Theory. Chialvo, A.A. (Department of Chemical Engineering, Princeton University, Princeton, New Jersey 08544-5263 (US)). *Journal of Chemical Physics (USA)*, 92(1): 673-679 (1 Jan 1990).

A recently proposed procedure for the determination of excess Gibbs free energy by computer simulation, due to Chialvo and Haile, and based on Kirkwood's coupling parameter interpretation of the chemical potential, is revised and improved. New theoretical expressions for excess Gibbs free energy, excess enthalpy and excess volume, are derived in this paper. The new equations allow the simultaneous determination of these quantities via isobaric–isothermal (NPT) simulations involving coupling-parameter charging from only one ideal solution (i.e., pure component), irrespective of

either the number of components in the mixture or the number of potential parameters involved. Theoretical expressions are derived which allow the determination of infinite dilution activity coefficients, pure component fugacity ratios, and Henry's constant ratios without resorting to infinite dilution simulations.

24065 Kinetic isotope effects for hydrogen diffusion in bulk nickel and on nickel surfaces. Rice, B.M. (Chemical Dynamics Corporation, Upper Marlboro, Maryland 20772 (USA)); Garrett, B.C.; Koszykowski, M.L.; Foiles, S.M.; Daw, M.S. *Journal of Chemical Physics (USA)*, 92(1): 775-791 (1 Jan 1990).

Diffusion coefficients for H, D, and T on a Ni(100) surface and in bulk Ni are calculated using variational transition state theory with semiclassical ground-state transmission coefficients using two potential energy surfaces obtained by the embedded atom method (EAM). The original EAM potential reproduces experimental bulk diffusion coefficients, but greatly overestimates the diffusion coefficients for H and D on Ni(100). By refining the empirical potential parameters, a new EAM potential is developed that accurately reproduces both the bulk and surface diffusion coefficients. The variational transition state theory calculations are used to analyze the unusually low (compared to gas phase) H/D kinetic isotope effects for diffusion in bulk and on the Ni(100) surface. For the temperature range for which experiments have been carried out, quantum mechanical tunneling contributes negligibly to the diffusion and, in these cases, the kinetic isotope effect is determined largely by the change in zero-point energy between the reactant equilibrium binding sites and the transition state. A near equality of the reactant and transition state zero-point energies leads to the unusually low kinetic isotope effects. Using the same refined EAM potential energy surface, the energetics of diffusion on the Ni(111) and Ni(110) surfaces are also presented. The barriers for diffusion on these two surfaces are sufficiently low, about 1.0 kcal/mol, that the approximation of uncorrelated hops needed to relate the computed hopping rate to the diffusion coefficient is suspect. Although diffusion coefficients were not computed, based upon an analysis of the zero-point energies at the reactants and saddle points, we predict that the H/D kinetic isotope effects for diffusion on these two surfaces will also be close to unity.

24066 Comment on "A perturbation–trajectory method for the study of gas–surface collision dynamics". Riley, M.E. (Sandia National Laboratories, Albuquerque, New Mexico 87185 (USA)); Coltrin, M.E.; Diestler, D.J.; Jezercak, M.; Agrawal, P.M.; Thompson, D.L.; Raff, L.M. *Journal of Chemical Physics (USA)*, 92(1): 817-818 (1 Jan 1990).

The perturbation-trajectory method (PTM) of Jezercak, Agrawal, Thompso and Raff for application to gas-surface collision processes is commented upon. The authors contend that the PTM does not function as a true thermal reservoir or heat bath. (AIP)

24067 Modern concepts in surface science and heterogeneous catalysis. Somorjai, G.A. (Lawrence Berkeley Lab., CA (USA)). *Journal of Physical Chemistry (USA)*, 94(3): 1013-1023 (8 Feb 1990).

Surface science studies using small-area single crystals and a combination of electron, ion, photon, and molecular beam scattering techniques have been exploring surface properties on the molecular level. Many new phenomena were discovered that could be used to recast the models or concepts we employ to describe surfaces. The surface structure exhibits relaxation, reconstruction, and the presence of steps and kinks on the atomic scale. Chemisorption causes adsorbate-induced restructuring of surfaces, and the substrate has a significant influence on the growth mode of the deposited material (epitaxy). The surface chemical bond is cluster like, thermal activation is needed for chemical bond breaking, and rough, more open surfaces are markedly more reactive than flat surfaces with close atomic packing. The adsorbate-adsorbate interaction that may be repulsive or attractive induces weakening of the adsorbate-substrate bond and ordering in the surface monolayer. Surface dynamics studies reveal low potential energy barriers for the diffusion of molecules along the surface (two-dimensional phase approximation) and rapid energy transfer between incident gas and surface atoms. Catalyzed surface reactions may be surface structure sensitive or structure insensitive and coadsorbed promoter atoms act by altering the structure and/or the bonding of adsorbed molecules.

24068 X-ray absorption fine structure study of amorphous germanium under high pressure. Freund, J. (Univ. of Washington, Seattle (USA)); Ingalls, R.; Crozier, E.D. *Journal of Physical Chemistry (USA)*, 94(3): 1087-1090 (8 Feb 1990).

The X-ray absorption fine structure (XAFS) of amorphous germanium under pressures ranging from 0.0 to 8.9 GPa is investigated. Contrary to some reports from the literature we cannot find a transition to crystalline germanium at about 6 GPa. Analysis of the XAFS phases of amorphous germanium and copper, which is used as a pressure marker, allows calculation of the bulk modulus at zero pressure, B_O, of the bonds (as opposed to the bulk modulus of the bulk material, containing voids) and its pressure derivative, B_O'. They are 97 $\pm$ 8 GPa and 6 $\pm$ 2, respectively. B_O is 30% larger than in crystalline germanium. Fair agreement is obtained with the two- and three-body potential energy formalism of Stillinger and Weber (1985).

24069 Combined effect of isotopic substitution, temperature, and magnetic field on the lifetimes of triplet biradicals. Wang, Jinfeng (Columbia Univ., New York, NY (USA)); Rao, V.P.; Doubleday, C. Jr.; Turro, N.J. *Journal of Physical Chemistry (USA)*, 94(3): 1144-1146 (8 Feb 1990).

Lifetimes τ for decay of triplet biradicals derived from 2-phenylcycloalkanones were measured by nanosecond transient absorption under conditions designed to probe the contribution of intersystem crossing and chain dynamics to the observed decay. The temperature dependence of τ was measured at both 0 and 2 kG magnetic field, and also in the presence of 0.004 M $MnCl_2$. Under a variety of conditions of temperature, solvent viscosity, and magnetic field, the lifetime of the biradical derived from 2-phenylcyclododecanone was compared with its perdeuterated analogue and with a 1:1 mixture of 1,2-$^{13}C_2$ and 1,12-$^{13}C_2$ isotopomers. The magnetic isotope effect on τ and the temperature dependence of Mn^{2+} quenching support chain dynamics as the rate-limiting step at -85°C and intersystem crossing as the rate-limiting step at room temperature. However, the magnetic field effect on τ reaches a maximum around -50°C and persists even at -99°C, in contrast to the magnetic isotope effect and Mn_{2+} quenching, which are absent at low temperature. The significance of this observation is discussed.

24070 Pressure dependence of the superfluid ^{4}He transition in two dimensions. Peters, D.S. (Lawrence Livermore National Lab., CA (USA)); Alder, B.J. *Journal of Physical Chemistry (USA)*, 94(3): 1147-1148 (8 Feb 1990). DOE Contract W-7405-ENG-48.

It is experimentally known that the superfluid transition temperature in three-dimensional (3D) ^{4}He is reduced at higher densities. A similar effect is predicted in two dimensions (2D) based upon path integral quantum Monte Carlo simulations for small systems which have been scaled to the thermodynamic limit by using Kosterlitz-Thouless (KT) theory.

24071 Similarities and differences in the C-C bond scission of ethylene and acetylene on supported Ir and Pt clusters. Wang, Pokang (Univ. of Illinois, Urbana-Champaign (USA)); Slichter, C.P.; Sinfelt, J.H. *Journal of Physical Chemistry (USA)*, 94(3): 1154-1157 (8 Feb 1990). DOE Contract AC02-76ER01198.

We have used NMR to study the C-C bond scission of adsorbed acetylene and ethylene on supported Pt and Ir clusters. We have monitored the extent of C-C bond scission by measuring the ^{13}C-^{13}C dipolar interaction. We have found that C-C bond scission of adsorbed ethylene has the same reaction path and activation energy (36 kcal/mol) on Pt and Ir. On the other hand, the predominant intermediate undergoing C-C scission in the case of adsorbed acetylene is different for the metals, and the activation energies are also different (37 kcal/mol on Ir and 53 kcal/mol on Pt). By measuring the ^{13}C-^1H dipolar interaction, we have found an extensive dehydrogenation of adsorbed acetylene prior to C-C bond scission on Pt clusters. The results are discussed in relation to Sinfelt's studies of the reaction kinetics of ethane hydrogenolysis and are shown to support the conclusions drawn by Sinfelt.

24072 Calculation of the pressure shifts of the quartet state of ruby. Winter, N.W. (Lawrence Livermore National Lab., CA (USA)); Ross, M.; Pitzer, R.M. *Journal of Physical Chemistry (USA),* 94(3): 1172-1174 (8 Feb 1990). DOE Contract W-7405-ENG-48.

Hartree-Fock and configuration interaction calculations have been carried out on the lowest quartet states of ruby (Al_2O_3:Cr^{3+}) using a cluster approximation for the crystal in order to determine the shifts of their relative energies with increasing pressure. The accuracy of the cluster was tested by calculating the equilibrium positions of Al^{3+} and Cr^{3+} with respect to displacement along the c axis and comparing to experiment. The predicted pressure, induced shifts of the $^4E(T_{2g})$, $^4A(T_{2g})$, $^4E(T^a{}_{1g})$, and $^4A(T^a{}_{1g})$ states are compared to measurements of Stephens and Drickamer (J. Chem. Phys, 1961, 35, 427) and are in good agreement at pressures below 10 GPa.

24073 Vapor-liquid phase equilibria of potassium chloride-water mixtures: Equation-of-state representation for KCl-H_2O and NaCl-H_2O. Hovey, J.K. (Lawrence Berkeley Lab., CA (USA)); Pitzer, K.S.; Tanger, J.C. IV; Bischoff, J.L.; Rosenbauer, R.J. *Journal of Physical Chemistry (USA),* 94(3): 1175-1179 (8 Feb 1990). DOE Contract AC03-76SF00098.

Measurements of isothermal vapor-liquid compositions for KCl-H_2O as a function of pressure are reported. An equation of state, which was originally proposed by Pitzer and was improved and used by Tanger and Pitzer to fit the vapor-liquid coexistence surface for NaCl-H_2O, has been used for representation of the KCl-H_2O system from 300 to 410°C. Improve parameters are also reported for NaCl-H_2O from 300 to 500°C.

24074 Bimetallic catalysts from alumina-supported molybdenum-iridium clusters. Shapley, J.R. (Univ. of Illinois, Urbana (USA)); Uchiyama, W.S.; Scott, R.A. *Journal of Physical Chemistry (USA),* 94(3): 1190-1196 (8 Feb 1990).

The heterometallic clusters $CpMoIr_3(CO)_{11}$ and $Cp_2Mo_2Ir_2(CO)_{1210}$ (Cp = η^5-C_5H_5) were deposited onto fumed alumina (Degussa Al_2O_3-C, 0.2 wt % Ir) as catalyst precursors. Comparable materials were prepared from $Ir_4(CO)_{12}$ and $Cp_2Mo_2(CO)_6$ as well as from a stoichiometric mixture (Ir_4 + $2Mo_2$) of these homometallic compounds. The supported compounds were activated by heating to 500°C in flowing H_2. Methane evolution profiles observed during activation were characteristic for each heterometallic cluster precursor and were distinct from profiles associated with the homometallic compounds. The IR-containing materials, [Mo_2Ir_2], [$MoIr_3$], [Ir_4], and [Ir_4 + $2Mo_2$], were active catalysts for the hydrogenolysis of n-butane at 215°C, whereas [Mo_2] was inactive. The [$MoIr_3$] catalyst exhibited enhanced activity (5-10 times) over the [Ir_4] and [Ir_4 + $2Mo_2$] catalysts, but the selectivity toward ethane production, 70-75%, was the same for all these samples. In contrast, the [Mo_2Ir_2] catalyst exhibited a change in ethane selectivity to ca, 50% but had catalytic activity comparable to the [Ir_4 + $2Mo_2$] material. Mo K edge X-ray absorption spectra were collected in order to characterize the metal-metal interactions. Fourier transforms of the EXAFS data collected on in situ activated samples of [$MoIr_3$], [Mo_2Ir_2], and [Ir_4 + $2Mo_2$] showed that each sample had structurally unique molybdenum sites.

24075 Nature of bonding in transition-metal aluminides. Brewer, L. (Lawrence Berkeley Lab., CA (USA)). *Journal of Physical Chemistry (USA),* 94(3): 1196-1203 (8 Feb 1990). DOE Contract AC03-76SF00098.

The binary systems of aluminum with transition metals are very complicated with many intermediate phases. Conventional chemical bonding models with consideration of availability of different electronic configurations and the role of generalized Lewis acid-base interactions provide an understanding of these systems. The stable phases of 77 binary systems of aluminum are characterized.

24076 Structures and reactivities of cyclopentadienylmolybdenum complexes with oxo and sulfido ligands. Tanner, L.D. (Univ. of Colorado, Boulder (USA)); Haltiwanger, R.C.; DuBois, M.R. *Inorganic Chemistry (USA),* 26(10): 1741-1746 (18 May 1988).

Solutions of [Cp′Mo(μ-S)(μ-SH)]$_2$ (Cp′ = C_5H_5, $C_5H_4CH_3$) have been oxidized by air to produce syn- and anti[Cp′MoO(μ-S)]$_2$. Chromatographic procedures for the isolation of each isomer are reported. The methylcyclopentadienyl derivatives have been characterized by x-ray diffraction studies. The syn isomer crystallizes in space group C2/c with a = 8.214 (2) Å, b = 11.957 (3) Å, c = 14.610 (2) Å, and β = 106.51 (2)°. The Mo_2S_2 unit is bent, and the distance between bridging sulfido atoms is 3.577 Å. anti-[MeCpMoO(μ-S)]$_2$ crystallizes in space group $P\bar{1}$ with a = 6.939 (1) Å, b = 7.197 (1) Å, c = 7.756 (1) Å, α = 103.73 (1)°, β = 90.16(1)°, and γ = 107.92(1)°. Each isomer reacts with [$(CH_3)_3Si]_2S$ in a reaction that exchanges sulfido for terminal oxo ligands and forms $(MeCpMo)_2S_4$ derivatives. Intermediate products syn- and anti-$(MeCpMo)_2(O)(S)(\mu\text{-}S)_2$ have also been isolated and characterized by spectroscopic methods. syn-$(MeCpMo)_2(O)(S)(\mu\text{-}S)_2$ undergoes a disproportionation upon heating to form $(MeCpMo)_2O_2S_2$ and $(MeCpMo)_2S_4$. Intermolecular oxo/sulfido transfer is also involved in the reaction of syn-$(MeCpMo)_2(O)(S)(\mu\text{-}S)_2$ with alkynes, which results in products of the formulations MeCpMo(O)(μ-S)$_2$Mo(SCR=C(R)S)-(MeCp) and MeCpMo(O)(μ-S)$_2$Mo(OCR=C(R)S)(MeCp). 15 refs., 3 figs., 5 tabs.

24077 Synthesis and reactivity of an unusual oxidation product of [$C_5H_5Mo(\mu$-S)(μ-SH)]$_2$. Tanner, L.D. (Univ. of Colorao, Boulder (USA)); Haltiwanger, R.C.; Noordik, J.; DuBois, M.R. *Inorganic Chemistry (USA),* 26(10): 1736-1741 (18 May 1988).

The reaction of a dilute solution of [CpMo(μ-S)(μ-SH)]$_2$ (Cp = C_5H_5) with 1 equiv of phenylacetylene under air leads to the formation of anti-CpMo(O)(μ-S)$_2$Mo(SCH=C(Ph)S)Cp (1) in 20% yield. Both syn and anti isomers of 1 can be synthesized by the reaction of [CpMo(SCH=C(Ph)S)]$_2$ with trifluoroacetic acid under air. The anti isomer has been characterized by an x-ray diffraction study. The complex crystallizes in space group $Pna2_1$, with a = 10.284 (6) Å, b = 15.175 (8) Å, c = 12.018 (7) Å, and V = 1875 (2) Å^3. The dinuclear complex contains two μ-sulfido ligands in a nonplanar Mo_2S_2 core, a terminal oxo ligand on one CpMo site, and a bidentate styrenedithiolate ligand coordinated to the second CpMo site. The cyclopentadienyl ligands are anti with respect to the metal-metal vector. The terminal oxo ligand in 1 is displaced by sulfide in the reaction with hexamethyldisilthiane. Complex 1 reacts with hydrogen to form water, $(CpMo)_2S_4$ derivatives, and organic products that result from hydrogenation and hydrolysis of the styrenedithiolate ligand.

24078 Rare-earth-metal iodide clusters centered by transition metals: Synthesis, structure, and bonding of $R_7I_{12}M$ compounds (R = Sc, Y, Pr, Gd; M = Mn, Fe, Co, Ni). Hughbanks, T. (Iowa State Univ., Ames (USA)); Corbett, J.D. *Inorganic Chemistry (USA),* 26(12): 2022-2026 (15 Jun 1988).

The compounds $R_7I_{12}M$ (M = Co, Ni for R = Sc; M = Fe, Co for R = Y; M = Mn, Fe, Co for R = Gd; M = Mn, Fe, Co, Ni for R = Pr) have been synthesized by reactions of RI_3, MI_2, and R metals at 750-950°C in sealed Nb or Ta containers. These compounds all adopt the $Sc(Sc_6Cl_{12}B)$ structure (space group $R\bar{3}$, Z = 3) with a transition metal at the cluster center (in place of boron). The seventh isolated R^{3+} ion can be substituted by Ca^{2+} in several of the Pr and Gd cases. The structural details of $Sc_7I_{12}Co$, $Y_7I_{12}Fe$, and $(Ca_{0.65}Pr_{0.35})(Pr_6I_{12}Co)$ were determined by single-crystal x-ray diffraction methods (a = 14.800, 15.351, 15.777 Å; c = 10.202, 10.661, 10.925 Å; R = 3.3, 3.8, 3.4%; R_w = 6.7, 3.3, 3.5%, respectively). The last of these presented twinning difficulties endemic to this structure type, but these were overcome satisfactorily by an approximate separation procedure. R-M distances in the clusters are short; Pr-Co = 2.770, Y-Fe = 2.621, and Sc-Co = 2.431 Å. While MO theory provides some useful guides to these compounds stability, the true breadth of the chemistry possible remains to be explored. 28 refs., 2 figs., 4 tabs.

24079 $Ca_{0.75}Nb_3O_6$: A novel metal oxide containing niobium-niobium bonds. Characterization and structure refinement from synchrotron powder x-ray data. Hibble, S.J. (Oxford Univ. (England)); Cheetham, A.K.; Cox, D.E. *Inorganic Chemistry (USA),* 26(15): 2389-2391 (29 Jul 1987).

A new mixed-metal oxide, $Ca_{0.75}Nb_3O_6$, has been characterized in the course of our investigations of the Ca-Nb-O system. The space group is Immm with cell constants a = 7.113 Å, b = 10.286 Å, and c = 6.563 Å. The structure was refined by using powder x-ray data obtained on the Brookhaven synchrotron. An extremely

short Nb-Nb bond of 2.578 Å is present within an Nb_2O_8 unit. 21 refs., 5 figs., 2 tabs.

24080 Observation of the formation of N^+ and ArN^+ in the collisions of $Ar^+(^2P_{3/2,1/2})$ with N_2. Flesch, G.D. (Ames Laboratory, U. S. Department of Energy and Department of Chemistry, Iowa State University, Ames, Iowa 50011 (US)); Ng, C.Y. *Journal of Chemical Physics (USA),* 92(5): 2876-2882 (1 Mar 1990).

Absolute total cross sections for the reactions, $Ar^+(^2P_{3/2,1/2})+N_2 \rightarrow N^+ + N + Ar$ [reaction (1)] and $ArN^+ + N$ [reaction (2)], have been measured in the center-of-mass collision energy ($E_{c.m.}$) range of 6.2–123.5 eV. The appearance energy for the formation of N^+ ($E_{c.m.}$=8.65±0.21 eV) is in agreement with the thermochemical threshold for reaction (1). The comparison of the collision energy dependence of the N^+ cross section with the photoionization efficiency spectrum of N^+ from N_2 suggests that the predissociative multielectron states of N^+_2, $\tilde{C}\ ^2\Sigma^+_u$, $\tilde{F}\ ^2\Sigma^+_g$, $\tilde{G}\ ^2\Sigma^+_g$, and $^2\Sigma^+_g\ (2\sigma_g)^{-1}$, which are responsible for the dissociative photoionization of N_2, also play a role in the formation of N^+ via reaction (1). Product ArN^+ ions of reaction (2) are only observed in the $E_{c.m.}$ range of 8.2–41.2 eV. At $E_{c.m.}$ slightly above the thermochemical thresholds of reactions (1) and (2), the majority of ArN^+ and N^+ ions are scattered backward and forward with respect to the center-of-mass velocity of reactant Ar^+, respectively. This observation is rationalized by a charge transfer predissociation mechanism which involves the formation of ArN^+ and N^+ ions via nearly collinear Ar^+-N-N collision configurations at $E_{c.m.}$ near the thresholds of reactions (1) and (2). At $E_{c.m.} \geq 11$ eV, more than 92% of the charge transfer product N^+_2 ions are found to be slow ions formed mostly by the long-range electron jump mechanism.

24081 Technetium-diphosphonate skeletal imaging agents: EXAFS structural studies in aqueous solution. Martin, J.L. Jr. (Univ. of Cincinnati, OH (USA)); Yuan, J.; Lunte, C.E.; Elder, R.C.; Heineman, W.R.; Deutsch, E. *Inorganic Chemistry (USA),* 28(15): 2899-2901 (26 Jul 1989). DOE Contract FG02-86ER60487.

Much controversy has existed as the to form of the ^{99}Tc-diphosphonates. The first evidence is presented herein for the existence of the complex Tc-MDP (MDP = methylenediphosphonate) in aqueous solution. Results of EXAFS studies of the HPLC-purified Tc-MDP are presented and used to establish the molecular structure of the compound.

24082 Temperature dependence of fluorescence from liquid butane, pentane, and hexane: Lifetimes and quantum yields. Preses, J.M. (Chemistry Department, Brookhaven National Laboratory, Upton, New York 11973 (US)); Holroyd, R.A. *Journal of Chemical Physics (USA),* 92(5): 2938-2942 (1 Mar 1990). DOE Contract AC02-76CH00016.

The rate constants for the decay of ultraviolet fluorescence from liquid butane, pentane, and hexane have been measured as a function of temperature between their respective freezing points and near-room temperature. The rate constants are well characterized as the sum of an activated and nonactivated term, as has been described previously. The parameters determining the rate constants are evaluated. Relative fluorescence quantum yields are also measured over the same temperature range. Normalization of the relative fluorescence quantum yields with absolute quantum yields measured previously at 195 K renders the relative determinations absolute. A comparison of the fluorescence results with the photochemical yields shows that a fraction of the initially formed upper excited states dissociates mainly into radicals, in competition with internal conversion to the fluorescing state.

24083 Encapsulation of lead sulfide molecular clusters into solid matrices. Structural analysis with x-ray absorption spectroscopy. Moller, K. (Univ. of New Mexico, Albuquerque (USA)); Bein, T.; Herron, N.; Mahler, W.; Wang, Ying. *Inorganic Chemistry (USA),* 28(15): 2914-2919 (26 Jul 1989). DOE Contract AS05-80ER10742.

Molecular-size PbS species have been stabilized in the open-pore structure of zeolite Y and mordenite via ion exchange with Pb(II) and subsequent treatment with H_2S at 295 K. Detailed analysis of synchrotron x-ray absorption data of the Pb L_{III}-edge shows that intrazeolite $PbO_2(O_z$ = zeolite oxygen) species in zeolite Y react with H_2S to form monomolecular $S_2Pb(I_z)_3$ species that are still anchored to the zeolite framework. The intrazeolite PbS phase appears to be more ordered at high loading levels of lead in zeolite Y than at low loading levels. The coordination of Pb(II) and the structure of PbS in the mordenite host is less ordered but basically very similar to that of the monomolecular species in Y. Optical absorption data for these samples agree very well with the structural EXAFS results. Larger PbS clusters have been stabilized in 85% ethylene-15% methacrylic acid copolymer films by a similar preparation procedure. EXAFS data indicate that the reaction forms PbS clusters with several Pb coordination shells and that the conversion of PbS is a function of Pb(II) loading levels. 23 refs., 9 figs., 3 tabs.

24084 Quenching of the doublet excited state of tris(polypyridine)chromium(II) ions by oxalate ions: An example of irreversible electron transfer. Steffan, C.R. (Iowa State Univ., Ames (USA)); Bakac, A.; Espenson, J.H. *Inorganic Chemistry (USA),* 28(15): 2992-2995 (26 Jul 1989). DOE Contract W-7405-ENG-82.

The kinetics and mechanism of the reductive quenching of ^2E CrL_3^{3+} (L = 2,2′-bipyridine, 1,10-phenanthroline, and their substituted analogues) by oxalate were studied. Quenching rate constants vary from 85.4 × 10^5 M^{-1} s^{-1} for the 5-chloro-1,10-phenanthroline complex to 0.21 × $10^5 M^{-1}$ s^{-1} for the 4,4′-dimethyl-2,2′-bipyridine complex and depend on the $E^0_{3+/2}$ value. The mechanism involves an ion-pairing preequilibrium followed by rate-limiting electron transfer. The $CO_2^{\bullet -}$ produced in the quenching step reacts with ground state CrL_3^{3+} to produce another mole of CrL_3^{2+} in the case of the 2,2′-bipyridine complex and its substituted analogues, while in the case of the 1,10-phenanthroline complex and its analogues a secondary transient is produced that decays to CrL_3^{2+}. 27 refs., 4 figs., 1 tab.

24085 Rectilinear diameters and extended corresponding states theory. Singh, R.R. (Department of Chemistry and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720 (US)); Pitzer, K.S. *Journal of Chemical Physics (USA),* 92(5): 3096-3099 (1 Mar 1990). DOE Contract AC03-76SF00098.

The amplitude of the rectilinear diameter is examined for a large number of normal fluids and a few other fluids. For the normal fluids, the slope of the diameter shows a linear dependence on the acentric factor, as do other fluid properties on a reduced basis. Thus, we conclude that the shape of the pair potential is the primary factor in determining the slope of the diameter rather than the relative strength of three-body forces, as has been suggested by analogy to recent results for rubidium and cesium. The situation for the near-critical singularity in the diameter remains ambiguous for normal fluids and a suggestion is made for its resolution.

24086 Thermal decomposition of the halide and pseudohalide derivatives of bis(cyclopentadienyl)titanium(IV). Brown, G.M. (Oak Ridge National Lab., TN (USA)). *Inorganic Chemistry (USA),* 28(15): 3028-3032 (26 Jul 1989). DOE Contract AC05-84OR21400.

The thermal decomposition reactions of $Ti(Cp)_2(X)_2$, where Cp is η^5-C_5H_5 and X is Cl^-, Br^-, NCS^-, NCO^-, and N_3^-, were studied at atmospheric pressure by temperature-programmed pyrolysis with analysis of the evolved gas by mass spectroscopy. The gas evolution versus temperature profile showed that the compounds decomposed in a single, sharp, symmetrical step with the loss of cyclopentadiene observed from all compounds. The pseudohalide-containing compounds evolved products of the breakdown of this moiety simultaneously with C_5H_6. The gas evolution versus temperature profiles were used to measure $\Delta H^{\ddagger}$ for the decomposition of the azide and cyanate compounds. The compound $Ti(Cp)_2(N_3)_2$ was used for the chemical vapor deposition of titanium-containing films on quartz of CaF_2 substrates at 400°C. Additional pyrolysis converts the film to an adherent, chemically resistant, refractory material. The infrared spectrum of the initial deposition product on a CaF_2 substrate was obtained. Chemical analysis and IR spectroscopy suggest the film contains a large excess of carbon over that required for stoichiometric TiC. Hydrocarbon evolution probably occurs by a hydrogen abstraction mechanism, which leads to

dehydrogenation of coordinated cyclopentadienyl. This dehydrogenated ring system appears to be the source of the excess carbon in the solid film. 29 refs., 1 tab.

24087 Resonance Raman spectra of electronically excited $M_2(dppm)_3$ complexes. Woodruff, W.H. (Los Alamos National Lab., NM (USA)); Gray, H.B.; Harvey, P.D.; Dallinger, R.F. *Inorganic Chemistry (USA),* 28(15): 3057-3059 (26 Jul 1989).

The resonance Raman spectra of d^{10}-d^{10} $M_2(dppm)_3$ (M = Pd, Pt; dppm = bis(diphenylphosphino)methane) complexes have been investigated by CW and time-resolved resonance Raman spectroscopy. The $^3(d\sigma^*p\sigma)$ excited-state frequencies are 152 (Pd-Pd) and 120 cm^{-1} (Pt-Pt); ground-state frequencies are 120 and 102 cm^{-1}, respectively. The increase in ν(M-M) upon excitation confirms that there is a stronger metal-metal bond with a correspondingly greater force constant in the excited state. The M-M force constant in each case indicates that the metal-metal bond shortens by ≈ 0.1 Å upon electronic excitation. 17 refs., 2 figs., 1 tab.

24088 A study of the reaction $O^+(^4S)+N_2$ using the tandem photoionization mass spectrometric method. Flesch, G.D. (Ames Laboratory, U. S. Department of Energy, Ames, IA (US)—Ames, Iowa 50011 (US)); Ng, C.Y. *Journal of Chemical Physics (USA),* 92(5): 3235-3236 (1 Mar 1990).

The reaction between oxygen ions and nitrogen molecules is studied by using tandem photoionization mass spectroscopy. This reaction is pertinent to the study of reaction occuring in the inosphere. (AIP)

24089 Synthesis and spectroscopic characterization of bis-pocket porphyrins: Tetrakis(2,6-dinitrophenyl)porphyrin and catalytic activity of a manganese(III) chloride derivative in alkane oxidation. Quintana, C.A. (Sandia National Labs., Albuquerque, NM (USA)); Assink, R.A.; Shelnutt, J.A. *Inorganic Chemistry (USA),* 28(18): 3421-3425 (6 Sep 1989). DOE Contract AC04-76DP00789.

The synthesis of tetrakis(2,6-dinitrophenyl)porphyrin (TDNPP) and tetrakis(2,6-diaminophenyl)porphyrin (TDAPP) has been achieved by modifying the Lindsey method as described. The new porphyrins serve as percursors for the synthesis of bis-deep-pocket metalloporphyrins that have completely enclosed, but dynamically accessible, cavities located adjacent to the central metal core on both faces of the macrocycle. Proton nuclear magnetic resonance spectroscopy of TDNPP shows that the porphyrin is substituted at the two phenyl positions ortho to the methine bridge carbon of the porphyrin. Fourier transform infrared spectroscopy demonstrates that the ortho substituents of the phenyl rings are in fact NO_2 groups for TDNPP and NH_2 groups for TDAPP. The manganese(III) chloride derivative of TDNPP was also synthesized and characterized by uv-visible absorption and resonance Raman spectroscopy. The Mn derivative was found to catalyze the hydroxylation of alkanes by using iodosylbenzene as the oxidant. 42 refs., 6 figs.

24090 Synthesis, structure, and ^{31}P NMR spectra of $Mo_2W_2Cl_8(PR_3)_4$ rectangular clusters. Carlin, R.T. (Ames Lab., IA (USA)); McCarley, R.E. *Inorganic Chemistry (USA),* 28(18): 3432-3436 (6 Sep 1989). DOE Contract W-7405-ENG-82.

The new compounds $Mo_2W_2Cl_8(PMe_3)_4 \cdot 4H_8O$ (I) and $Mo_2W_2Cl_8[P(n\text{-}Bu)_3]_4$ (II) have been prepared by cycloaddition reactions of $MoW(O_2CCMe_3)_4$. Yellow-green crystals of I provided crystallographic data for a complete structure determination: tetragonal, space group $P4_22_12$, a = 12.6443 (8) Å, c = 11.2854 (9) Å, V = 1804.3 Å^3 Z = 2, R = 0.034, R_w = 0.045. Disordering of the Mo and W atoms on the metal atom sites permits only averaged M-M, M-Cl, and M-P distances for the rectangular cluster units. Of principal interest were the M≡M and M-M distances of 2.275 (1) and 2.843 (1) Å, respectively, for the short and long edges of the Mo_2W_2 rectangular cluster units. A study of the $^{31}P[^1H]$ NMR spectrum for a solution of II showed that coupling of the Mo-^{4}W dinuclear units provided two isomers, IIa and IIb, in a ratio of ca. 1.5:1.0. Isomer IIa was assigned as arising from head-to-tail coupling, and IIb as arising from head-to-head coupling of the two MoW units. Electronic spectral data for II are also reported. 16 refs., 6 figs., 4 tabs.

24091 Crystal structures of $XeF_5^+MF_4^-$ (M = Ag, Au) and their relevance to the basicity and oxidizability of MF_4^-. Lutar, K. (Univ. of Ljubljana (Yugoslavia)); Jesih, A.; Leban, I.; Zemva, B.; Bartlett, N. *Inorganic Chemistry (USA),* 28(18): 3467-3471 (6 Sep 1989). DOE Contract AC03-76SF00098.

$XeF_5^+AuF_4^-$ has been prepared from $BrF_3 \cdot AuF_3$ by displacement of BrF_3 with XeF_6. The salt interacts quantitatively with KrF_2 in anhydrous HF, below 0°C, to yield $XeF_5^+AuF_6^-$. XeF_5AuF_4 (I) is isostructural with XeF_5AgF_4 (II), and these compounds crystallize in space group I4/m with the following unit cell dimensions: I, a_0 = 5.735 (5) Å, c^0 = 20.007 (17) Å, V = 658 (2) Å^3, Z = 4; II, a_0 = 5.593 (2) Å, c_0 = 20.379 (5) Å, V = 637.5 (8) Å^3, Z = 4. The structure of II was solved by the Patterson method and refined to conventional R and R_W values of 0.077 and 0.090, respectively. The structure contains double layers of XeF_5^+ and layers of AgF_4^- ions, all layers being parallel to the ab plane. The XeF_5^+ ion had C_{4v} symmetry with Xe-F(axial) = 1.853 (19) Å, Xe-F(equatorial) = 1.826 (9) Å, and F(axial)-Xe-F(equatorial) = 77.7 (3)°. The anion (site symmetry D_{2h}), which is not significantly different from D_{4h} symmetry, has Ag-F = 1.902 (11) Å. Differences between the XeF_5AgF_4 and XeF_5AuF_4 structures are attributed to lower ligand charges in the anion of the former, relative to those in the latter, and these in turn are related to observed differences in the basicity and oxidizability of the anions. 24 refs., 5 figs., 4 tabs.

24092 Gas-phase reactions of Nb^+ and Ta^+ with alkanes and alkenes. C-H bond activation and ligand-coupling mechanisms. Buckner, S.W. (Purdue Univ., West Lafayette, IN (USA)); MacMahon, T.J.; Byrd, G.D.; Freiser, B.S. *Inorganic Chemistry (USA),* 28(18): 3511-3518 (6 Sep 1989). DOE Contract FG02-87ER13776.

The gas-phase reactions of Nb^+ with small alkanes and alkenes are reported. Nb^+ sequentially activates C-H bonds in ethene six times to produce $NbC_{2n}H_{2n}^+$ (n = 1-6). The C_2H_2 ligands in this reaction couple via migratory insertion of the acetylene units. Ethane sequentially reacts with Nb^+ five times. Ligand coupling is proposed for these reactions as well. Comparison of $NbC_4H_6^+$ produced from isobutane, n-butane, and ethane indicates the presence of at least two isomeric forms. $NbC_4H_4^+$ ions produced from ethene, cyclobutane, and 1-butene produced similar CID spectra, supporting the presence of one structure. Excited Nb^+ produced by direct laser desorption reacts with methane to produce $NbCH_2^+$ and $NbCH_3^+$, but collisional cooling with argon quenches the reaction. Primary reactions indicate a strong preference for C-H insertion, and reaction products indicate 1,3-hydrogen migration when β-hydrogens are not present. The reactions with alkanes are compared to those with Ta^+, which reacts with CH_4 four times to produce $TaC_4H_8^+$. Ta^+ and Nb^+, which react similarly, are by far the most reactive metal ions toward C-H bond activation reported to date. CID spectra of the products form the Nb^+ reactions indicate that the extensive dehydrogenation reactions occur via ligand coupling and, for larger alkanes (C_5 and C_6), dehydrocyclization. For example, Nb^+ undergoes a novel dehydrocyclization reaction with pentane to generate $Nb(Cp)^+$ (Cp = cyclopentadienyl). Nb^+ reacts with cyclopentane to generate $Nb(Cp)_2^+$ as a second product. 34 refs., 3 figs., 2 tabs.

24093 Quenching of the ^2E excited state of tris(polypyridine)chromium(III) ions with titanium(III). Huston, P. (Iowa State Univ., Ames (USA)); Espenson, J.H.; Bakac, A. *Inorganic Chemistry (USA),* 28(19): 3671-3674 (20 Sep 1989). DOE Contract W-7405-ENG-82.

The kinetics of the quenching of the ^2E excited state of chromium polypyridine complexes by Ti(III) were investigated at 25°C in 1.0 M LiCl/HCl. The dependence of the rate on hydrogen ion concentration indicates that both $Ti(H_2O)_6^{3+}$ and $(H_2O)_5Ti\text{-}(OH)^{2+}$ quench. The quenching rate constants for Ti^{3+} are in the range (0.26-3.7) x 10^7 M^{-1} s^{-1} and those for $TiOH^{2+}$ are in the range (0.81-9.7) x 10^8 M^{-1} s^{-1} when a value K_a = 4.6 x 10^{-3} is used. The formation of a stable Cr(II) product was observed spectrophotometrically, indicating back electron transfer occurs too slowly to measure. This is explained by the instability of TiO^+, the immediate product of back electron transfer. Plots of log k_q vs ΔE^0 are linear for the quenching by both Ti^{3+} and $TiOH^{2+}$. 42 refs., 3 figs., 2 tabs.

24094 Kinetics and mechanism of electron transfer from pentacarbonylrhenate to metal carbonyl dimers by infrared stopped-flow spectroscopy. Corraine, M.S. (State Univ. of New York, Buffalo (USA)); Atwood, J.D. *Inorganic Chemistry (USA),* 28(20): 3781-3782 (4 Oct 1989).

The results of the reactions of $Re(CO)_5^-$ with the dimers $Mn_2(CO)_{10}$, $CO_2(CO)_8$ and $cp_2Mo_2(CO)_6$ are reported herein. Infrared spectroscopy was used for product examination. The reaction rates observed had a first order dependence on the oxidant and reductant, and the dependence on the dimer was of the order $Cp_2Mo_2(CO)_6$, $CO_2(CO)_8$, $Mn_2(CO)_{10}$. Both inner-sphere and outer-sphere mechanisms are ruled out by the data. 10 refs., 2 figs., 3 tabs.

24095 Nucleophilicites of the metal carbonyl anions: Effects of ligands, solvent, and countercation. Lai, Chungkung (State Univ. of New York, Buffalo (USA)); Feighery, W.G.; Zhen, Yueqian; Atwood, J.D. *Inorganic Chemistry (USA),* 28(20): 3929-3930 (4 Oct 1989).

The effects of ligand environment, solvent, and countercation on the nucleophilicity of metal carbonyl anions have been measured. The reactions of the metal carbonyl anion with MeI were measured by infrared stopped-flow spectrometry. The nucleophilicity was found to be relatively unaffected by changes in solvent. Also, a rather small effect of the countercation was observed with a slower rate for the more interacting cation. The rate of reaction of the ligands with MeI was found to directly parallel the donor capability of the ligand. The oxidation potentials of the anions were also measured and are reported. 11 refs., 1 fig., 3 tabs.

24096 Alkoxides of the hexanuclear niobium and tantalum cluster units $[M_6X_{12}](OMe)_2{\cdot}4MeOH$ and $M'_2[Ta_6Cl_{12}]_6{\cdot}6MeOH$ (M = Nb, Ta; X = Cl, Br; M′ = alkali metal). Brnicevic, N. (Tudjer Boskovic Institute, Zagreb (Yugoslavia)); Mustovic, F. *Inorganic Chemistry (USA),* 27(25): 4532-4535 (14 Dec 1988).

In an inert atmosphere, the diamagnetic, mixed halide-methoxide clusters of the composition $[M_6X_{12}](OCH_3)_2{\cdot}4CH_3OH$ (M = Nb, Ta; X = Cl, Br) are prepared by the exchange reaction of the terminal halides in the clusters $[M_6X_{12}]X_2{\cdot}8H_2O$ by methoxide groups. The mixed halide-methoxide clusters are not soluble in methanol, but from suspensions in this solvent they dissolve slowly with further addition of alkali-metal methoxides. From concentrated alkaline solution in an oxygen-containing atmosphere a series of diamagnetic compounds $M'_2[Ta_6Cl_{12}](OCH_3)_6{\cdot}6CH_3OH$ (M′ = alkali metal) having all six terminal positions of the cluster units occupied by methoxide groups are isolated and their properties described.

24097 Synthetic routes to new polypyridyl complexes of osmium(II). Kober, E.M. (Univ. of North Caroina, Chapel Hill (USA)); Caspar, J.V.; Sullivan, B.P.; Meyer, T.J. *Inorganic Chemistry (USA),* 27(25): 4587-4598 (14 Dec 1988).

New luminescent complexes of Os(II) that contain either 2,2′-bipyridine (bpy) or 1,10-phenanthroline (phen) as the chromophorib acceptor ligand have been prepared by a combination of established and new synthetic methods. Extensive use of Os(IV) and Os(III) precursors, e.g., $Os^{IV}(bpy)Cl_4$ and $mer\text{-}Os^{III}(PMe_2Ph)_3Cl_3$ has led to the preparation of materials with ancillary ligands such as tertiary phosphines as preparative intermediates, including $Os^{III}(bpy)(PMe_2Ph)Cl_3$ and $cis\text{-}Os^{II}(phen)(diphosphine)Cl_2$. Further substitution of chloro ligands into complexes such as these results in the formation of emissive complexes of Os(II). Another new synthetic route utilizes the versatile Os(II) precursor $Os(bpy)_2CO_3$, which allows the facile preparation of dicationic, disubstituted species such as $[Os(bpy)_2(norbornadiene)]^{2+}$. Another general procedure, based on the control of solvent and temperature in the substitution chemistry of $cis\text{-}Os(bpy)_2Cl_2$, has been further developed to produce a variety of new complexes of the types $cis\text{-}[Os(bpy)_2(L)Cl]^+$ and $cis[Os(bpy)_2(L)_2]^{2+}$, where L is a phosphine, arsine, nitrogen, or olefin donor ligand. In a few cases, phosphine entering groups cause the cis geometry to be unfavorable and new $trans\text{-}[Os(bpy)_2(L)_2]^{2+}$ complexes have also been isolated. The resultant complexes comprise the largest family of transition-metal-based excited-state reagents with tunable photophysical and redox properties available. When possible, the new complexes have been characterized by UV-visible spectroscopy, emission spectroscopy, cyclic voltammetry, and ^{31}P and/or ^1H NMR spectroscopy.

24098 Characterization of nickel(II)-nickel(IV) linear-chain compounds by nickel nd chlorine K-edge EXAFS. *Inorganic Chemistry (USA),* 27(25): 4521-4523 (14 Dec 1988).

The use of metal and halogen absorption edge x-ray adsorption fine structure (EXAFS) for characterization of mixed-valence linear-chain materials is reported. The EXAFS technique was used to establish the structural parameters for Ni(II)-Ni(IV) mixed-valence compounds.

24099 Synthesis of high-surface-area α-$LiAlO_2$. Poeppelmeier, K.R. (Northwestern Univ., Evanston, IL (USA)); Chiang, C.K.; Kipp, D.O. *Inorganic Chemistry (USA),* 27(25): 4523-4524 (14 Dec 1988). DOE Contract FG05-86ER75295.

The preparation of $LiAlO_2$ is described. $LiAlO_2$ was found to adopt three different structures, the hexagonal phase, the orthorhombic phase, and a tetragonal phase. These three polymorphs are formed under similar reaction conditions, and mixtures of the polymorphs usually result if the preparative reaction is carried out below 700°C. Crystal structures of the $LiAlO_2$ prepared at several reaction temperatures are reported. Surface area of the -$LiAlO_2$ was studied by the BET method, and the results are reported. 15 refs., 1 fig., 2 tabs.

24100 Rotational and translational effects in collisions of electronically excited diatomic hydrides. Crosley, D.R. (SRI International, Menlo Park, CA (USA)). *Journal of Physical Chemistry (USA),* 93(17): 6273-6282 (24 Aug 1989).

Collisional quenching and vibrational energy transfer proceed competitively with rotational energy transfer for several excited states of the diatomic radicals OH, NH, and CH. This occurs for a wide variety of molecular collision partners. This phenomenon permits the examination of the influence of rotational motion on the collision dynamics of these theoretically tractable species. Measurements can also be made as a function of temperature, i.e., collision velocity. In $OH(A^2\Sigma^+)$, both vibrational transfer and quenching are found to decrease with an increase in rotational level, while quenching decreases with increasing temperature. This behavior indicates that for OH anisotropic attractive forces govern the entrance channel dynamics for these collisions. The quenching of $NH(A^3\Pi_i)$ by many (although not all) collision partners also decreases with increasing rotational and translational energy, and $NH(c^1\Pi)$ behaves much like $OH(A^2\Sigma^+)$. However, the quenching of $CH(A^2\Delta)$ appears to decrease with increasing rotation but increases with increasing temperature, suggesting in this case anisotropic forces involving a barrier or repulsive wall. Such similarities and differences should furnish useful comparisons with both simple and detailed theoretical pictures of the appropriate collision dynamics.

24101 Kinetic study of the reactions of CN with ethane and propane. Hess, W.P. (Sandia National Labs., Livermore, CA (USA)); Durant, J.J. Jr.; Tully, F.P. *Journal of Physical Chemistry (USA),* 93(17): 6402-6407 (24 Aug 1989).

Absolute rate coefficients for the reactions of CN with ethane, propane, and five of their deuterated isotopes are determined over the temperature range 294-736 K by using the laser photolysis/CW laser-induced-fluorescence technique. The measured rate coefficients for the reactions of CN with C_2H_6 (k_1) and C_2D_6 (k_2) are well described by the three-parameter modified Arrhenius expressions $k_1(T) = (7.40 \times 10^{-15})T^{1.29}$ exp(+512 cal mol^{-1}/RT) cm^3 $molecule^{-1}$ s^{-1} and $k_2(T) = (8.32 \times 10^{-16})T^{1.57}$ exp(+460 cal mol^{-1}/RT) cm^3 $molecule^{-1}$ s^{-1}. The rate coefficient for the reaction of CN with the half-deuterated ethane compound, CH_3CD_3 (k_3), is well described ty (1/2)(k_1 + k_2). We measure rate coefficients for CN reactions with C_3H_8 (k_4), C_3D_8 (k_5), $C_3H_6D_2$ (k_6), and $C_3D_6H_2$ (k_7) and derive site-specific rate constants for abstraction of primary and secondary hydrogens. These rate coefficients, on a per hydrogen atom basis, are, in the units cm^3 $molecule^{-1}$ s^{-1}, $k_H^P(T) = (3.58 \times 10^{-15})T^{1.14}$ exp(+566 cal mol^{-1}/RT), $k_D^P(T) = (2.63 \times 10^{-16})T^{1.47}$ exp(+568 cal mol^{-1}/RT), $k_H^S(T) = (3.30 \times 10^{-13})T^{0.56}$ exp(+649 cal mol^{-1}/RT), and $k_D^S(T) = (2.96 \times 10^{-13})T^{0.52}$ exp(+656 cal mol^{-1}/RT). The k_4 through k_7 are well represented by the sum of the appropriate three-parameter expressions for H- and D-atom abstraction from primary and secondary sites.

4004 Electrochemistry

Refer also to citation(s) 23919, 23920, 24021, 24048, 24059

24102 (K/CSD/INF–88/23) **Fluid dynamics analysis of a rotating axisymmetric part using FIDAP.** Giles, G.E.; Kirkpatrick, J.R.; Wendel, M.W.; Bullock, J.S. IV. Oak Ridge Gaseous Diffusion Plant, TN (USA). Mar 1990. 32p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OT21400. Order Number DE90008733. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The effect of fluid flow on electrochemical plating on a rotating axisymmetric part was investigated by using a finite element computer code, FIDAP. The results from these investigations compare well with analytical results for laminar flow conditions. The addition of a nonrotating shield was also investigated for laminar flow conditions. An attempt to extend these analyses to turbulent conditions was unsuccessful. 6 refs., 14 figs.

24103 (K/CSD/TM–85) **BEPIN user's manual.** Bland, T.B. (Oak Ridge Gaseous Diffusion Plant, TN (USA)); Giles, G.E.; Bullock, J.S. IV. Oak Ridge Gaseous Diffusion Plant, TN (USA). Feb 1990. 112p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OT21400. Order Number DE90008172. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

BEPIN is an interactive code that produces input for the BEPLATE code. The BEPIN/BEPLATE system is used to simulate electrochemical plating of material on rotating axisymmetric parts. BEPIN was developed to make the process of using BEPLATE much friendlier. BEPIN uses the Forms Management System on the VAX/VMS computer systems to process the geometry information produced by the analyst and generates the input required by BEPLATE. This report includes the information required to run BEPIN, specifically, brief descriptions of BEPLATE and BEPIN, a tutorial consisting of a typical, brief descriptions of BEPLATE and BEPIN, a tutorial consisting of a typical BEPIN session, copies of all forms and help screens used in BEPIN, and additional reference material. Although this report contains sufficient material to run BEPIN, the analyst must also use the companion document for BEPLATE to be able to produce effective analyses. 8 refs., 40 figs.

24104 A model of the DNA transient orientation overshoot during gel electrophoresis. Lim, H.A. (Supercomputer Computations Research Institute, The Florida State University, Tallahassee, Florida 32306-4052 (USA)); Slater, G.W.; Noolandi, J. *Journal of Chemical Physics (USA),* 92(1): 709-721 (1 Jan 1990).

Linear dichroism and electric birefringence measurements show that when an electric field is applied to a DNA molecule at equilibrium in an agarose gel, the isotropic molecular conformation quickly orients in the field direction, reaching first a maximum "overshoot" orientation before it relaxes towards a somewhat less oriented but still anisotropic steady-state conformation. We present here a simple analytical model of this overshoot effect together with numerical results from a computer simulation of gel electrophoresis. The predicted dependence of the overshoot time and orientation upon field intensity and molecular size are in good agreement with experimental results. The dynamics of the overshoot involves U-shape conformations that disappear only after the internal elastic forces completely dominate the electric forces. It is also predicted that a different overshoot regime takes place for low electric fields and small molecular sizes, and that a primary and a secondary overshoot may appear for very large molecules.

4005 Photochemistry

Refer also to citation(s) 23904, 23905, 24008, 24015, 24017, 24018, 24069, 24839, 25069

24105 Photoionization of the 3σ and 1π orbitals of CH. Lee, M. (Arthur Amos Noyes Laboratory of Chemical Physics, California Institute of Technology, Pasadena, California 91125 (US)); Stephens, J.A.; McKoy, V. *Journal of Chemical Physics (USA),* 92(1): 536-540 (1 Jan 1990).

We report the results of theoretical studies of photoionization cross sections and photoelectron angular distributions for the 3σ and 1π levels of CH leading to the $A\ ^1\Pi$, $a\ ^3\Pi$, and $X\ ^1\Sigma^+$ molecular ions. The calculations employed multiplet-specific Hartree–Fock potentials and numerical photoelectron continuum orbitals, obtained using the iterative Schwinger variational method. Noticeable nonstatistical behavior of the cross sections is seen for the 3σ level near threshold, although deviations are not significant at higher photon energies. A comparison with some previous theoretical studies is made.

24106 The production of $O(^3P)$ in the 157 nm photodissociation of CO_2. Zhu, Y. (Department of Chemistry, University of Illinois at Chicago, Box 4348, Chicago, Illinois 60680 (US)); Gordon, R.J. *Journal of Chemical Physics (USA),* 92(5): 2897-2901 (1 Mar 1990).

The branching ratio was measured for the production of $O(^3P)$ in the photodissociation of CO_2 at 157 nm. A gas mixture consisting of CO_2, H_2, and Ar was irradiated with an F_2 excimer laser, while the relative concentration of $O(^3P)$ was monitored continuously using atomic resonance fluorescence. The $O(^1D)$ product was removed by either reacting with H_2 or by being quenched by CO_2. At a high H_2/CO_2 ratio a residual $O(^3P)$ signal persisted which was due to the nascent photofragments of CO_2. A Stern–Volmer analysis indicated that the fraction of $O(^3P)$ produced is 5.9%. Control experiments using O_2 and N_2O as precursor molecules confirmed this interpretation of the data. A mechanism is proposed based on curve crossing from the $^1B_2$ to the $^3B_2$ potential energy surfaces of CO_2. Since the $^1B_2$ state is bent, a substantial fraction of the absorbed energy is initially in bending motion, resulting in a long-lived chaotic trajectory which has many opportunities to cross over to the triplet surface. A similar model proposed by Tully to explain the quenching of $O(^1D)$ by CO is in qualitative agreement with our data.

24107 Dynamics of H_2 elimination from 1,4-cyclohexadiene. Cromwell, E.F. (Materials and Chemical Sciences Division, Lawrence Berkeley Laboratory, Berkeley, CA (US)— Department of Chemistry, University of California, Berkeley, California 94720); Liu, D.; Vrakking, M.J.J.; Kung, A.H.; Lee, Y.T. *Journal of Chemical Physics (USA),* 92(5): 3230-3231 (1 Mar 1990). DOE Contract AC03-76SF00098.

The dynamics of H_2 elimination from 1,4-cyclohexadiene (CHDN), dissociated with 212 nm light, have been studied by state specific probing of the H_2 product via (1+1) REMPI using a transform limited vacuum ultraviolet laser system. The quantum state distributions, the translational energy distribution and the Doppler profiles were measured giving a "rotational temperature" of ≅1600 K, a "vibrational temperature" of ≅4000 K, and a translational energy of ≅30 kcal/mol for H_2. Anisotropy in the Doppler profiles indicates that the H_2's velocity vector is aligned parallel to its rotational angular momentum vector.

24108 Reaction dynamics of photosubstitution intermediates of the triruthenium cluster $Ru_3(CO)_{12}$ as studied by flash photolysis with infrared detection. DiBenedetto, J.A. (Univ. of California; Santa Barbara (USA)); Ryba, D.W.; Ford, P.C. *Inorganic Chemistry (USA),* 28(18): 3503-3507 (6 Sep 1989). DOE Contract FG03-85ER13317.

The reaction dynamics of intermediates formed by 308-nm XeCl excimer-laser excitation of the triruthenium cluster $Ru_3(CO)_{12}$ in room-temperature isooctane solution were studied by using a flash-photolysis apparatus with a tunable infrared laser probe source and Hg/Cd/Te fast-risetime ir detector. The primary photoreaction is the dissociation of CO to give $Ru_3(CO)_{11}$, which is rapidly trapped in second-order reactions by CO or by an added nucleophile such as tetrahydrofuran. The rate constants for such trapping are shown t be 2.4×10^9 and $6.1 \times 10^9\ M^{-1}\ s^{-1}$ for CO and THF, respectively. The intermediate $Ru_3(CO)_{11}(THF)$ reacts with CO to re-form $Ru_3(CO)_{12}$ via an apparent first-order dissociation of the THF with a rate constant about $2 \times 10^6\ s^{-1}$. The flash-photolysis apparatus with the ir detection system is described in detail. 17 refs., 6 figs.

24109 Reductive quenching of ruthenium polypyridyl sensitizers by cyanometalate complexes. Mallouk, T.E. (Univ. of Texas, Austin (USA)); Krueger, J.S.; Mayer, J.E.; Dymond, C.M.G. *Inorganic Chemistry (USA),* 28(18): 3507-3510 (6 Sep 1989). DOE Contract FG05-87ER13789.

Laser flash photolysis/transient absorbance and emission spectroscopy were used to probe the nature of the reductive quenching of ruthenium polypyridyl sensitizers by cyanometalate electron donors in aqueous solution. Quenching rate constants and approximate cage escape efficiencies were measured for a number of donor/sensitizer pairs; octacyanometalates ($Mo(CN)_8^{4-}$, $W(CN)_8^{4-}$) exhibit much higher cage escape efficiencies, typically 40-80%, than do hexacyanometalates ($Fe(CN)_6^{4-}$, $Os(CN)_6^{4-}$). Cage escape efficiencies vary with the overall charge of the sensitizer; geminate ion pair recombination competes most efficiently with cage escape when the electron donor and acceptor have 4+ and 4-overall charges, respectively. No dependence of cage escape efficiency on thermodynamic driving force for the back-electron-transfer reaction is observed. Little or no dependence on ionic strength or counterion is observed. Steady-state and time-resolved luminescence experiments with $Ru(bpy)_3^{2+}$ (bpy = 2,2′-bipyridine) show that the quenching process is dynamic at low cyanometalate concentrations and that association of the cationic sensitizer with the anionic cyanometalates occurs at higher concentrations. Even under these conditions, quantum yields for charge separation approach unity with octacyanometalate electron donors. 29 refs., 2 figs., 2 tabs.

24110 Photochemical generation of alkyl radicals and their reactions with methyl viologen radical cation and with transition-metal complexes in aqueous solution. Bakac, A. (Iowa State Univ., Ames (USA)); Espenson, J.H. *Inorganic Chemistry (USA),* 28(20): 3901-3904 (4 Oct 1989). DOE Contract W-7405-ENG-82.

The irradiation of aqueous solutions of $RCo([14]aneN_4)(H_2O)^{2+}$ (R = CH_3, C_2H_5, 1-C_3H_7, CH_2Cl, CH_2Br, CH_2OCH_3) with visible light, $\lambda \leq 400$ nm, results in the homolysis of the cobalt-carbon bond. These complexes are quite unreactive toward a variety of dealkylating and redox reagents and thus represent a convenient source of small unstabilized carbon-centered radicals in the presence of potential substrates. The radicals react rapidly with the methyl viologen radical cation, k_{MB} = (1-2) x 10^9 M^{-1} s^{-1}. The kinetics of the formation of RCr^{2+} and $RCo([14]aneN_4)(H_2O)^{2+}$ in the reactions of radicals with Cr^{2+} and $Co([14]aneN_4)(H_2O)_2^{2+}$, respectively, were studied by using MV^+ as a probe. The respective rate constants have values k_{Cr} = (1.9-2.4) x 10^8 M^{-1} s^{-1} and k_{Co} = (1-2) x 10^7 M^{-1} s^{-1} for all the radicals examined. 36 refs., 2 figs., 1 tab.

24111 Polarized pump-probe spectroscopy of photosystem I antenna excitation transport. Causgrove, T.P. (Iowa State Univ., Ames (USA)); Yang, Shumei; Struve, W.S. *Journal of Physical Chemistry (USA),* 93(18): 6844-6850 (7 Sep 1989).

Polarized photobleaching profiles were obtained by using pump-probe techniques with ≈ 1.5-ps resolution at 645-681 nm in solutions of native photosystem I particles (Chl/P700 ≈ 200) from spinach. The isotropic Chl a ground-state recovery dynamics at wavelengths between 660 and 681 nm exhibit at least three decay components; triexponential fits yield lifetimes of <5 ps, 25-40 ps, and 200-250 ps. The isotropic photobleaching decay is far more rapid at 645-655 nm, exhibiting ≈ 2 ps decay time at the shortest wavelength. Since this spectral region spans the Chl b Q_y transition, the latter kinetics may arise from excitation migration from peripheral Chl b pigments to longer wavelength Chl a pigments. The depolarization lifetimes exhibited by Chl a anisotropic photobleaching profiles vary considerably with wavelength between 660 and 681 nm, in a manner which is consistent with Foerster excitation transport rates computed from photosystem I core antenna absorption spectra. While electronic excitation may be rapidly homogenized across the Chl a core antenna spectrum, the slow depolarization time scales (5-13 ps) show that such rapid homogenization does not extend spatially over the entire core antenna. The results are consistent with a core antenna model in which the various Chl a spectral forms are grouped into heterogeneous clusters of chromophores.

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Refer also to citation(s) 24120, 24121, 24122, 24123, 24124, 24125, 24126, 24127, 24128, 24129

24112 (JINR–18-88-549) **Temperature effects in the process of radiation graft postpolymerization of styrene onto porous PET film.** Zhitaryuk, N.I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions); Kuznetsov, V.I.; Zagorets, P.A. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions. 1988. 3p. (In Russian). Order Number DE90621332. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Temperature effects ≈ 30-100 deg C of postirradiation grafting of styrene onto porous PET film are studied. The film was irradiated by rays of ^{137}Cs. The cause of sharp decrease in the grafting rate under decreasing of temperature up to crossing the glass transition region of the polymer-monomer system are discussed. 6 refs.; 1 fig.; 1 tab.

24113 (JINR-E–18-88-540) **Track structure in some heavy-ion irradiated plastic films.** Apel', P.Yu.; Didyk, A.Yu.; Kravets, L.I.; Kuznetsov, V.I. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions. 1988. 4p. Order Number DE90621331. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The changes occurring in thin polyethylene terephthalate (PETP), polycarbonate (PC) and polypropylene (PP) films irradiated with heavy ions have been investigated. The track etching properties were studied in the submicroscopic diameter range of 1-60nm. The method of absorption spectroscopy in ultraviolet and infrared regions viscosymetry of polymer solution and sol-gel analysis were used to investigate radition chemical processes in the polymers. It has been found that in all the three polymers both the chain rupture and cross linking processes occur simultaneously. The chain ruptures predominate in the track core with a diameter of several nanometers. The cross linking process takes place in the vicinity of the track core at radii of up to 30-50nm and appears most clearly in PETP where cross linking events prevail over the destruction at large distances from the ion path. 14 refs.; 1 fig.

24114 (UCID–21940) **Computerized tomography of a simulated waste canister.** Martz, H.E.; Roberson, G.P.; Schneberk, D.J.; Skeate, M.F.; Perkins, D.; Azevedo, S.G. Lawrence Livermore National Lab., CA (USA). 7 Feb 1990. 19p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008014. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Radioscopy and transmission x-ray computerized tomography (TCT) were used to analyze as simulated waste canister. This study was performed to demonstrate the qualitative and quantitative possibilities obtained by TCT scanners over radioscopy and how TCT can be applied toward the solution of materials and waste management problems. This report provides a brief summary of the scanner (CATALYST) used, a description of the waste canister and its contents, and an analysis of three radiographic views and the two scans obtained at two different slice planes on the canister. The usefulness of TCT is demonstrated by how well it reveals the interior details and spatial positions of items within the simulated waste canister. This paper ends with a summary of this study and what further development is required for this technology to be better used in materials and waste management. 9 refs., 13 figs.

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Refer also to citation(s) 23942, 24036

24115 (CEAC-R–2-89) **Quality control of the ^{113}Sn-^{113m}In generator.** Morin Zorilla, J. (Centro de Estudios Aplicados al Desarrollo de la Energia Nuclear, La Habana (Cuba)); Olive, E.; Isaac, M.; Cruz, J. Comision de Energia Atomica, La Habana (Cuba). 1989. 41p. (In Spanish). Order Number DE90621274. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Methods for quality control of ^{113}Sn-^{113m}In generators are compared and recommended the most convenient to applicate in hospitals and in more specialized quality control laboratories. The quality of ^{113}Sn-^{113m}In generator produced by POLATOM (Poland) is also evaluated. The product met the requirements of the International Pharmacopeia.

24116 (CEAC-R-3-89) **Chemical and physical quality control of the HIPPURAN-^{131}I.** Morin Zorilla, J. (Centro de Estudios Aplicados al Desarrollo de la Energia Nuclear, La Habana (Cuba)); Olive, E.; Isaac, M.; Cruz, J. Comision de Energia Atomica, La Habana (Cuba). 1989. 18p. (In Spanish). Order Number DE90621275. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Some physico-chemical methods for analytical control of Hippuran-^{131}I are compared. The most convenient to applicate in hospitals and in more specialized quality control laboratories are recommended. The quality of Hippuran-^{131}I produced by ISOTOP (USSR) is also evaluated. The product met the requirement of the International Pharmacopeia.

24117 (JINR-12-88-500) **Investigation of astatine cation electromigration.** Hung, T.K.; Milanov, M.; Roesch, F.; Khalkin, V.A. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 10p. (In Russian). Order Number DE90621261. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Electromigration of astatine (^{210,211}At) has been investigated in aqueous solutions of 0.25 mole L^{-1} $H(Na)ClO_4$-$5x10^{-3}$ mole L^{-1} $K_2Cr_2O_7$ or $Na_2S_2O_8$ at 25 deg C, $0.7 \leq pH \leq 10.4$. Like $K_2Cr_2O_7$, $Na_2S_2O_8$ oxidizes astatine only to $At(\Theta^+)$, i.e. to an univalent cation, stabilized in the form of protonized hypoastatic acid $(H_2O)_nAt^+$. The literature data on oxidation of astatine by $Na_2S_2O_8$ to $At^{3+}(AtO^+)$ were not confirmed. The mean mobility of the $At(\Theta^+)$ cation is well described by the empiric equation $U=U \text{ deg } 0_{At}{}^{(\Theta)+}/(1+K_{dp}xa_{H+}{}^{-1})x(1+\delta xpH)$ where K_{dp} 7.6(3.0)x10^{-5} mole L^{-1} is the deprotonation constant of $(H_2O)_nAt^+$, δ=0.18; u deg $0_{At}(\Theta)^+$=+3.80(5)x10^{-4} $cm^2V^{-1}s^{-1}$. In solutions of $K_2Cr_2O_7$ with pH>1.7 and in solutions without oxidation agents $At(\Theta)^+$ is unstable and reduces to the neutral form, probably, At^0. 26 refs.; 1 fig.; 1 tab.

24118 (JINR-E-6-88-594) **Selective concentration of the lanthanides with simultaneous purification from scandium.** Gorski, B. (Joint Inst. for Nuclear Research, Dubna (USSR)); Korotkin, Yu.S.; Kosyakov, V.N. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 7p. Order Number DE90621252. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to J. Radioanal. Nucl. Chem.

The solvent extraction of the rare earth elements, yttrium and scandium by troctylphosphine oxide in the presence of strong complexing (DTPA) and various salting-out ($Cu(NO_3)_2$, $Al(NO_3)_3$) agents has been studied. As a result, a technique was developed for the extraction-chromatography recovery of the rare earth elements and yttrium with simultaneous purification practically practically from all the elements, including scandium, usually present in mineral samples. 8 refs.; 6 figs.; 1 tab.

24119 (JINR-R-6-88-635) **Gas-chemical separation of radioactive thallium isotopes from lead targets in the presence of sulfur vapours.** Jin, K.U.; Timokhin, S.N.; Domanov, V.P.; Korotkin, Yu.S. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions. 1988. 11p. (In Russian). Order Number DE90621276. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Conditions of the formation of volatile sulfides of lead and thallium taken in macroquantities and as carrierless radionuclides, their thermochromatographic and thermosublimatographic behaviour were studied. Sulphur vapours were used as a reagent and the carrier gas was argon. The composition of compounds being formed is discussed. The procedure of the production of radioactive samples of thallium is proposed. Chemical yield of radioisotopes of thallium is near 100 %, and their radiochemical purity is about 99.98 %. 22 refs.; 8 figs.; 2 tabs.

24120 (ZfK-612) **Electromigration of carrier-free radionuclides. 9: Protolysis of sup 131I-iodate in aqueous solutions.** Roesch, F.; Hung, T.K.; Milanov, M.; Khalkin, V.A. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1988. 7p. (In German). Order Number DE90621262. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Using a special type of on line electromigration measurements of γ-emitting radionuclides in homogeneous aqueous electrolytes free of supporting materials the protolysis reaction of ^{131}I-iodate was studied. For $H(K)NO_3$ and $H(Na)ClO_4$ electrolytes, μ = 0.25, T = 298.1(2) K, stoichiometric protolysis constant K_s = 2.7(1) l·mole^{-1} and individual ion mobility of the acid anion $u_{IO_3}{}^{-\circ}$ = -2.82(5) · 10^{-4} $cm^2s^{-1}V^{-1}$ were obtained. (author).

24121 (ZfK-613) **Electromigration of carrier-free radionuclides. 10: Hydrolysis of sup 209-211At-At(I) in aqueous solutions.** Roesch, F.; Hung, T.K.; Milanov, M.; Khalkin, V.A. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1988. 10p. (In German). Order Number DE90621263. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Using a special type of on line electromigration measurements of γ-emitting radionuclides in homogeneous aqueous electrolytes free of supporting materials the hydrolysis reactions of $^{209-211}$At-At(I) were studied. By reason of electromigration of the astatine in acidic solutions containing $S_2O_8{}^{2-}$ in direction of the cathode up to pH ≈ 4 an upper limit of the hydrolysis constant of monovalent astatine cation of $pK_1 \geq 4$ is derived. In electrolytes without external oxidation agents the valency of At(I) is stabilized by complex formation. In electrolytes containing $5 \cdot 10^{-2}$ M X^-, X = chloride or bromide, dependence of $AtX_2{}^-$formations on proton concentration was detected in the range of pH 2 - 4. This can be interpreted as an effect of At(I) hydrolysis reaction. (author).

24122 (ZfK-614) **Electromigration of carrier-free radionuclides. 11: Complex formations of sup 239Np-Np(V) with oxalate, tartrate and sulphate in neutral solution.** Roesch, F.; Dittrich, S.; Buglanov, G.V.; Milanov, M.; Khalkin, V.A.; Dreyer, R. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1988. 13p. (In German). Order Number DE90621264. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Using a special type of on line electromigration measurements of γ-emitting radionuclides in homogeneous aqueous electrolytes free of supporting materials the complex formation reactions of ^{239}Np-Np(V) with oxalate, tartrate and sulphate ligands in neutral electrolytes were studied. Stoichiometric stability constants for oxalate complexes of lgK_1 = 3.77(2), 3.90(4) and 3.57(4) as well as lgK_2 = 2.21(20), 2.37(3) and 2.38(12) were obtained in perchlorate electrolytes of overall ionic strenghtes μ = 0.05, 0.10 and 0.30, respectively. Similar results were found in nitrate electrolytes of μ = 0.10: lgK_1 = 3.75(4) and lgK_2 = 2.38(5). The corresponding data are lgK_1 = 1.76(7), lgK_2 = 0.72(15) for tartrate ligand, μ = 0.10 ($ClO_4{}^-$), and lgK_1 = 1.1(1) for sulphate ligand, μ = 0.30 ($ClO_4{}^-$); T = 298.1(1) K. However, signs and amounts of individual ion mobilities of the Np(V) complex ions calculated are difficult to interprete. Therefore the existence of a NpO^{3+} cation is postulated. (author).

24123 (ZfK-615) **Electromigration of carrier-free radionuclides. 12: Reactions of sup 239Np-Np(V) with acetate and citrate ligands in neutral solutions.** Roesch, F.; Dittrich, S.; Buglanov, G.V.; Milanov, M.; Khalkin, V.A.; Dreyer, R. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1988. 11p. (In German). Order Number DE90621265. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Using a special type of on line electromigration measurements of γ-emitting radionuclides in homogeneous aqueous electrolytes free of supporting materials the complex formation reactions of carrier-free ^{239}Np-Np(V) with acetate and citrate ligands in neutral solutions, T = 298.1(1) K, were studied. In the acetate system, μ = 0.30 ($ClO_4{}^-$), stoichiometric stability constants of lgK_1 = 0.96, lgK_2 0.61, were obtained. In the citrate system reduction of Np(V) was observed. Signs and amounts of individual ion mobilities of the acetato complex ions calculated confirm a hypothesis on existence of a NpO^{3+} cation. (author).

24124 (ZfK-626) **Nitrido complexes of technetium.** Abram, U.; Abram, S. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1987. 34p. (In German). Order Number DE90621277. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In this report synthesis, characterization and chemical behaviour of coordination compounds of the element technetium are reported containing a geminal nitrogen ligand. In addition, an evaluation of the in-vitro behaviour of the complexes is given as well as a list of all literature to this matter. (author).

24125 (ZfK–634) **Electromigration of carrier-free radionuclides. 13: Ion mobilities and hydrolysis of sup 241Am-Am(III) in aqueous inert electrolytes.** Roesch, F.; Reimann, T.; Buglanov, G.V.; Milanov, M.; Khalkin, V.A.; Dreyer, R. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1988. 19p. (In German). Order Number DE90621266. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Using a special type of on line electromigration measurements of γ-emitting radionuclides in homogeneous aqueous electrolytes free of supporting materials the electromigration behaviour of the carrier-free ^{241}Am-Am(III) in inert electrolytes, μ = 0.1 (ClO_4^-), T = 298.1(1) K, was studied. Basing on experimental dependencies of the overall ion mobilities of ^{241}Am-Am(III) on pH between pH 5.5 and 12.9 the stoichiometric hydrolysis constants $p\beta_3$ = 28.8(9) and pK_1 = 6.9(2) were obtained. For K_4 a limitation of $pK_4 > 13.9(3)$ was possible, because no formation of anionic hydrolysis products in solutions pH < 12.9 was registrated. The individual ion mobility of the ^{241}Am-Am(III) degrees in the range pH 5.5 - 3 from +6.85(15) up to +5.50(15) $\cdot 10^{-4}$ $cm^2s^{-1}V^{-1}$. Dependencies of this effect on overall ionic strength, inert electrolyte anion, and temperature of the electrolytes were studied in detail both in acidic and neutral solutions. (author).

24126 (ZfK–635) **Electromigration of carrier-free radionuclides. 14: Complex formations of sup 241Am-Am(III) with oxalate and sulphate in aqueous solutions.** Roesch, F.; Reimann, T.; Buglanov, G.V.; Milanov, M.; Khalkin, V.A.; Dreyer, R. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1988. 10p. (In German). Order Number DE90621267. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Using a special type of on line electromigration measurements of γ-emitting radionuclides in homogeneous electrolytes free of supporting materials the complex formation of carrier-free ^{241}Am-Am(III) were studied in perchlorate electrolytes, μ = 0.10, T = 298.1(1) K. Stoichiometric stability constants for oxalate ligand of lgK_1 = 5.01(13), 5.11(13) and 5.38(18) as well as lgK_2 = 3.15(15), 3.19(14) and 3.58(26) were obtained at overall ionic strengthes of μ = 0.10, 0.05 and 0.01, respectively. The corresponding thermodynamic stability constants are lgK_1^0 = 5.90(15) and lgK_2^0 = 3.73(18). For sulphate ligand values of lgK_1 = 2.5(2) were obtained both in acidic and neutral solutions, μ = 0.10. (author).

24127 (ZfK–636) **Electromigration of carrier-free radionuclides. 15: Hydrolysis and oxalate complex formations of sup 249Cf-Cf(III) in aqueous solutions.** Roesch, F.; Reimann, T.; Buglanov, G.V.; Milanov, M.; Khalkin, V.A.; Dreyer, R. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1988. 10p. (In German). Order Number DE90621268. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Using a special type of on line electromigration measurements of γ-emitting radionuclides in homogeneous electrolytes free of supporting materials the hydrolysis and the complex formations of carrier-free ^{249}Cf-Cf(III) with oxalate in diluted perchlorate electrolytes, T = 2.98.1(1) K, were studied. Stoichiometric hydrolysis constants of $p\beta_3$ 18.6(9) and pK_1 = 6.2(2) were calculated in μ = 0.10 electrolytes. For the formation of anionic hydrolysis products a limitation of $pK_4 \geq 13.9(3)$ was derived. The stoichiometric stability constants of the oxalato complexes are lgK_1 4.80(8) and lgK_2 = 3.55(11), μ = 0.01. (author).

24128 (ZfK–651) **Principles of electromigration measurements: Individual ion mobilities in reaction equilibrea in aqueous solutions.** Roesch, F. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1988. 22p. (In German). Order Number DE90621269. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Basing on experimental literature data, obtained by means of different analytical techniques, ratios between individual ion mobilities of central and complex ions in equilibrium reactions in aqueous solutions (hydrolysis, protonisation, complex formation) are discussed. The data pairs are compared introducing normalized individual ion mobilities of the complex species in respect to the individual ion mobilities of the corresponding central ions. The central ion itselfs is considered with the normated individual ion mobility of value 1. The correlations give evidence to proportionalities of individual ion mobilities of complex and central ions according to the ratios of its charges. Some practical and theoretical aspects of the correlations are discussed. (author).

24129 (ZfK–652) **Principles of electromigration measurements: Calculation models of stability constants.** Roesch, F. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1988. 13p. (In German). Order Number DE90621270. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Basing on experimental applications of a modified version of on line electromigration measurements of γ-emitting radionuclides in homogeneous aqueous electrolytes free of supporting materials conceptions on calculation of stoichiometric and thermodynamic stability constants are carried out. Normalized ion mobilities were discussed, reflecting changes of the overall ion mobility of the radioelement in its equilibrium reaction in respect to the individual ion mobilities of the central ion at identic electrolyte parameters (temperature, overall ionic strength). With model reactions as well as with complex formations of Tl(I) with bromide and sulfate, respectively, examples of practical realizations of the conceptions are shown. (author).

24130 Intercalation reactions of the neptunyl(VI) dication with hydrogen uranyl phosphate and hydrogen neptunyl phosphate host lattices. Dorhout, P.K. (Univ. of Wisconsin, Madison (USA)); Kissane, R.J.; Abney, K.D.; Avens, L.R.; Eller, P.G.; Ellis, A.B. *Inorganic Chemistry (USA)*, 28(15): 2926-2930 (26 Jul 1989).

The hydrated layered solids hydrogen uranyl phosphate, HUO_2PO_4, HUP, and its isostructural neptunyl analogue, $HNpO_2PO_4$, HNpP, can be intercalated with UO_2^{2+} and NpO_2^{2+} ions to yield a family of layered, hydrated solids that have been characterized by x-ray powder diffraction and by infrared, Raman, and electronic spectroscopy. Aqueous reactions of HUP with UO_2^{2+} and HNpP with NpO_2^{2+} lead to hydrated layered solids $(UO_2)_3(PO_4)_2$, UP, and $(NpO_2)_3(PO_4)_2$, NpP; preparation of UP from HUP and of NpP from HNpP can also be effected by thermal decomposition of the parent solids, thus affording a set of self-intercalation reactions that are reversible. Cross-intercalation reactions (UO_2^{2+} into HNpP; NpO_2^{2+} into HUP) also proceed under stoichiometric conditions. Conducting the cross-intercalation reactions with high concentrations of intercalating ion leads to substantial substitution of actinyl ions in the host lattice sheets. The intercalation reactions of HUP and HNpP are shown to be selective by the marked preference found for intercalating Np(VI) over Np(V), as evidenced by the lack of reactivity of NpO_2^+ toward either host. Characterization by x-ray powder diffraction revealed that all of the solids could be indexed on the basis of tetragonal unit cells; the a lattice constant is $\approx$ 6.95 Å in all samples, but intercalation of actinyl ions increases the interlamellar spacing, c/2, from $\approx$ 8.7 Å in HUP and HNpP to $\approx$ 11.2 Å. Vibrational and optical properties of the intercalated solids are derived from transitions characteristic of the actinyl ions comprising the solids. 24 refs., 5 figs., 1 tab.

4008 Combustion, Pyrolysis, and High-Temperature Chemistry

Refer also to citation(s) 23888, 23894, 23972, 24027, 24148, 24331

24131 (DOE/ER/13282–7) **Aromatics oxidation and soot formation in flames: Progress report, August 15, 1987–August 14, 1990.** Howard, J.B.; McKinnon, J.T.; Shandross, R.A.; Pope, C.J. Massachusetts Inst. of Tech., Cambridge, MA (USA). Dept. of Chemical Engineering. Feb 1990. 51p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER13282. Order Number DE90008950. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The research reported here is concerned with the kinetics and mechanisms of aromatics oxidation and soot formation in flames. The scope includes detailed measurements of profiles and stable and radical species concentrations and soot-particle number concentration and size distribution through the reaction zone of low-pressure flat premixed flames. Intermediate species identifications and net reaction rates calculated from the profile measurements are used to test postulated reaction mechanisms. The aromatics oxidation work is focused mainly on benzene, and the soot formation work is primarily concerned with the particle inception or nucleation stage. Particular objectives are to identify and

to determine rate constants for the main benzene oxidation reactions in flames, and to characterize the soot precursor species and the mechanisms and kinetics of the transition from molecules to nascent soot particles. To these ends stable and radical species concentrations and soot particle size and concentrations are measured as functions of distance or time through the reaction zone of low-pressure premixed flat flames. From the data, net reaction rates are calculated and possible reaction mechanisms are identified and subjected to critical testing and kinetics evaluation. 64 refs., 29 figs., 3 tabs.

24132 (DOE/METC–88/6094, pp. 112-116) **The chemistry of the interaction of sodium and sulfur in flames.** Steinberg, M. (Univ. of California, Santa Barbara (USA)); Schofield, K. USDOE Morgantown Energy Technology Center, WV (USA). Jun 1988. (CONF-880656–: Annual coal fuel heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 14-16 Jun 1988). In *Proceedings of the annual coal fuel heat engines and gas stream cleanup systems contractors review meeting.* Order Number DE88001088. Available from NTIS, PC A20/MF A01.

The program objectives are the identification of the dominant reactions controlling sodium/sulfur chemistry, the development of a kinetic model for the gas phase chemistry of the system, and a more quantitative description of the sodium/sulfur species distribution in the hot gases in combustion driven gas turbines. Temperature, (OH), and (Na) profiles have been measured in series of fuel rich and lean $H_2/O_2/N_2$ and rich $C_2H_2/O_2/N_2$ flames with and without sulfur. SO_2 was added to the lean flames and H_2S to the rich flames to minimize thermal contributions of these additives. The measurements cover a wide range of stoichiometries with flame temperatures varying from 1650 to 2400 K. Most of the current effort is directed toward modeling the chemistry in the H_2/O_2N_2 flames. Since sodium/sulfur compound formation is greater in the rich flames, the authors have focused the analysis on this system. Of the possible sodium/sulfur compounds noted above, NaSO appears to be a most promising primary product they initially have examined this possibility. Results are discussed.

24133 **Propagation of a high-energy laser beam through a cloud of burning carbon particles.** Chitanvis, S.M. (Theoretical Division, Los Alamos National Laboratory, MS K723, Los Alamos, New Mexico 87545 (US)); Zardecki, A. *Journal of the Optical Society of America, Part A: Optics and Image Science (USA),* 7(1): 26-33 (Jan 1990).

The change in the propagation characteristics of a high-energy laser beam traversing a dense collection of carbon particles, as the irradiated carbon particles undergo combustion, is calculated by means of the radiative transfer equation. This allows one to predict the spatiotemporal shape of a laser pulse. The effects of the changing size distribution of the burning carbon particles on the propagation are also discussed.

24134 **Chemical Kinetic Data Base for Combustion Chemistry Part 4. Isobutane.** Tsang, W. (Chemical Kinetics Division, National Institute of Standards and Technology, Gaithersburg, Maryland 20899 (USA)). *Journal of Physical and Chemical Reference Data (USA),* 19(1): 1-68 (Jan 1990).

This publication contains evaluated and estimated data on the kinetics of reactions involving isobutane, *t*-butyl radical and isobutyl radical and various small inorganic and organic species which are of importance for the proper understanding of isobutane combustion and pyrolysis. It is meant to be used in conjunction with the kinetic data given in earlier publications, which is of direct pertinence to the understanding of methane, ethane, methanol and propane pyrolysis and combustion, but which also contains a large volume of data that are applicable to the isobutane system. The temperature range covered is 300–2500 K and the density range 1×10^{16} to 1×10^{21} molecules cm^{-3}.

24135 **Behavior of particulates in thermal plasma flows.** Chyou, Y.P. (Univ. of Minnesota, Minneapolis (USA)); Pfender, E. *Plasma Chemistry and Plasma Processing (USA),* 9(1): 45-71 (Mar 1989). DOE Contract FG02-85ER13433.

Injection of particulate matter into a thermal plasma represents one of the approaches used in thermal plasma processing. The injected particles are usually treated as a dispersed phase, governed by the equation of motion and the rate equations for heat and mass transfer in Lagrangian coordinates. A stochastic approach is introduced to take particle dispersion into account due to turbulent fluctuations by randomly sampling instantaneous flow fields. Three-dimensional effects are also considered which are mainly due to particle injection and the presence of a swirl component. A modified approach for investigating noncontinuum effects on plasma-particle heat transfer is proposed, incorporating both electric and aerodynamic effects on the boundary layer around a particle immersed into a thermal plasma. Comparisons of theoretical predictions based on the present model with available experimental data are, in general, in reasonable agreement.

24136 **Modeling of plasma jets with superimposed vortex flow.** Chyou, Y.P. (Univ. of Minnesota, Minneapolis (USA)); Pfender, E. *Plasma Chemistry and Plasma Processing (USA),* 9(2): 291-328 (Jun 1989). DOE Contract FG02-85ER13433.

This work is concerned with analytical studies of thermal plasma jets, which are finding increasing interest for thermal plasma processing. A two-dimensional model for turbulent plasma jets with superimposed vortex flow has been developed, incorporating multiple time scales for velocity and temperature fluctuations and a density-weighted averaging for the density fluctuation effect. Results show that adding swirl to the flow field for confined and free jets induces strong axial and radial pressure gradients near the nozzle exit, causing a rapid decay of the axial velocity with increasing distance from the nozzle. Comparisons with cold flow show similar trends close to the nozzle exit, but further downstream, the axial velocities increase again, especially for larger swirl numbers. Comparisons of theoretical predictions based on the present model with available experimental data are, in general, in reasonable agreement.

24137 **Mechanism and modeling of nitrogen chemistry in combustion.** Miller, J.A. (Sandia National Laboratories, Livermore, CA (USA). Combustion Research Facility); Bowman, C.T. *Progress in Energy and Combustion Science (UK),* 15(4): 287-338 (1989).

Our current understanding of the mechanisms and rate parameters for the gas-phase reactions of nitrogen compounds that are applicable to combustion-generated air pollution is discussed and illustrated by comparison of results from detailed kinetics calculations with experimental data. In particular, the mechanisms and rate parameters for thermal and prompt NO formation, for fuel nitrogen conversion, for the Thermal De-NO_x and RAPRENO$_x$ processes, and for NO_2 and N_2O formation and removal processes are considered. Sensitivity and rate-of-production analyses are applied in the calculations to determine which elementary reactions are of greatest importance in the nitrogen conversion process. Available information on the rate parameters for these important elementary reactions has been surveyed, and recommendations for the rate coefficients for these reactions are provided. The principal areas of uncertainty in nitrogen reaction mechanisms and rate parameters are outlined. 83 figs., 3 tabs., 179 refs.

24138 **Probe measurements in argon plasma jets operated in ambient argon.** Capetti, A. (Univ. of Minnesota, Minneapolis (USA)); Pfender, E. *Plasma Chemistry and Plasma Processing (USA),* 9(2): 329-341 (Jun 1989). DOE Contract FG02-85ER13433.

Measurements of local enthalpies and velocities have been performed in plasma jets generated by a DC plasma spray torch, using an enthalpy probe. The torch has been operated in an argon confined atmosphere at different currents and argon flow rates. The validity of the measured enthalpy and velocity profiles has been checked by performing energy flux and mass flux balances, which show reasonable agreement between the input quantities, measured independently, and those obtained by integrating over the experimental profiles. The data are compared with those obtained by operating the same torch in ambient air. The results show that temperatures and velocities measured in pure argon are substantially higher than those in air, and consequently, the jets in argon appear wider and substantially longer.

42 ENGINEERING

Refer also to citation(s) 23831

4202 Facilities, Equipment, and Techniques

Refer also to citation(s) 23567, 23606, 23673, 23819, 23878, 23919, 24345, 24880, 25211, 25228

24139 (AD-A-215443/3/XAB) **Development and delivery of a lead vapor cell suitable for stimulated Raman scattering. Final report, September 1980-September 1981.** Bricks, B.G. General Electric Co., Philadelphia, PA (USA). Space Systems Div. Sep 1981. 39p. Available from NTIS, PC A03/MF A01.

A high temperature, lead vapor cell for use in stimulated Raman scattering of XeCl laser radiation was designed, manufactured, tested and delivered. Recirculating wick structures were used for metal vapor confinement. During a performance life test, 835 hours of continuous operation was achieved with a lead vapor density > or = 1.6x10 to the 17th power/cc (1270 C equivalent temperature) in an active volume 2.5 cm by about 85 cm.

24140 (AD-A-215690/9/XAB) **Effects of scaling on the performance of magnetoplasmadynamic thrusters. Engineer's thesis.** Schmidt, W.M. Naval Postgraduate School, Monterey, CA (USA). Jun 1989. 53p. Available from NTIS, PC A04/MF A01.

A combined theoretical and empirical numerical model was developed which predicts the performance of continuous electrode coaxial magnetoplasmadynamic thrusters as a function of thruster dimensions, mass flow rate, and input current. This model was used to predict the effects of scaling on these thrusters. The model predicts that for scaling factors down to one-half, relations can be found relating the performance of one thruster to another. The model was used to examine these relationships for four different thruster configurations over a broad range of operating currents. The thrusters examined consisted of two geometries and their half scale counterparts. A conclusion from the analysis is that scaling down the size of the thruster by 50% can reduce the total power input by 30% to 40% at comparable efficiencies. However, this is at the cost of increasing the specific impulse by a factor of two which may render the thruster inappropriate for the intended missions.

24141 (AWE-44/99/5) **Development history of crimp shear tools. Item D11 Decommissioning Group.** Farmer, A.K. (Ministry of Defense, Aldermaston (UK). Atomic Weapons Establishment); Holden, G.V. Ministry of Defense, Aldermaston (UK). Atomic Weapons Establishment. Feb 1988. 59p. (PCMWP-DDTF/P-118;DOE-RW-88.050). Order Number DE90621854. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

This report gives information on the continuing development of a range of crimp/shear tools aimed at separating items of radioactive plant, eg, gloveboxes, from a variety of service pipelines which could also be internally contaminated. (author).

24142 (CONF-900559-13) **Motion planning in a dynamic domain.** Fukimura, Kikuo (Oak Ridge National Lab., TN (USA)); Samet, H. Oak Ridge National Lab., TN (USA). 1990. 8p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract AC05-84OR21400. IRI-88-02457. From IEEE robotics and automation conference; Cincinnati, OH (USA); 13-18 May 1990. Order Number DE90008556. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Motion planning is studied in a time-varying environment. Each obstacle is a convex polygon that moves in a fixed direction at a constant speed. The robot is a convex polygon that is subject to a speed bound. A method is presented to determine whether or not there is a translational collision-free motion for a polygonal robot from an initial position to a final position, and to plan such a motion, if it exists. Our method makes use of the concepts of configuration spaces and accessibility. An algorithm is given for motion planning in such an environment and its time complexity is analyzed. 16 refs., 9 figs.

24143 (LLNL-M-256) **Mechanical engineering design practices.** Lawrence Livermore National Lab., CA (USA). Jan 1989. 103p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008544. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The design process is an organized, interactive engineering activity that results in a well-defined concept of a product and a specific plan to turn that concept into reality. The designer creates a series of concepts and selects the best possible solution utilizing the most logical resources and tools available. Through the end product is specified in the form of drawings, computer images, sketches, and engineering specifications, designing involves more than simply putting a drawing together and having the part made in the shop. Designing should be an iterative process with planned steps and check-points. Every design involves solving a particular problem, analyzing what will it take to do the job, and planning the series of steps and activities that will make the concept a concrete object. Each design involves making choices-choices in materials, instrumentation, manufacturing processes, and fabrication personnel. And finally, every design should have the input of several people, each of whom can offer advice, assistance, guidance, constructive critiques, and support. 17 refs., 3 figs., 7 tabs.

24144 (PB-90-142324/XAB) **Guide to contracting for rural and small urban transit systems. Final report.** Gattis, J.L.; Doeksen, G.A.; Towler, C.J. Oklahoma Univ., Norman, OK (USA). Oct 1989. 250p. Available from NTIS, PC A11/MF A02.

The report presents guidelines and a step-by-step approach to contracting that will assist rural and small urban transit systems with the contracting of transit services. It examines two types of transit contracting: contracting the entire transit service, and contracting an aspect of the operation such as fuel or maintenance. The report emphasizes transit agency contracting with a private company, and includes a discussion of the principles for contracting along with examples of contracting methods, sample documents used by various agencies, and case studies in which rural and small urban system transit managers related their contracting experiences, and a literature review. In addition the report contains guidelines for identifying and assessing contracting opportunities, studying the feasibility of contracting, attracting contractors, developing the contract documents, bidding and awarding contracts, administering contracts, and evaluating the continuation of contracting services.

24145 (SAND-88-0714) **The impacts of transportation within the United States of spent reactor fuel from domestic and foreign research reactors.** Cashwell, J.W.; Luna, R.E.; Neuhauser, K.S. Sandia National Labs., Albuquerque, NM (USA). 23 Jan 1990. 83p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (TTC-0794). Order Number DE90008157. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This analysis was the basis for the transportation analysis in the environmental assessment to support the US Department of Energy's renewal of its policy of receiving, and making financial settlement for, US-origin fuel from research reactors (Federal Register Notice 52-FR49198, December 30, 1987). This report examines the radiological and nonradiological impacts of transporting research reactor spent fuel within the mainland United States as a result of US Department of Energy acceptance of spent fuel from US and foreign research reactors. The analysis is based upon historical shipping trends from activities covered by previous policy. A bounding analysis is also performed to address peak yearly shipments. Impacts from research reactor spent fuel transportation are compared with those for pressurized water reactor spent fuel transportation to establish a basis for comparison with previously accepted activities.

4204 Heat Transfer and Fluid Flow

Refer also to citation(s) 23751, 23919

24146 (DOE/ER/13333-6) **Mixing of viscous fluids: Behavior of microstructures and chaos: Progress report, March 1, 1990-February 28, 1991.** Ottino, J.M. Massachusetts Univ., Amherst, MA (USA). Dept. of Chemical Engineering. Nov 1989. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-85ER13333. Order Number DE90008871. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The work corresponding to the third year follows largely the plans outlined in the previous progress report (second year) and the original proposal. The work involved computational and experimental studies in two main areas: (1) investigations of chaotic mixing of "single fluids" in two-dimensional time-periodic flows, and (2) dynamics of active microstructures in such flows (e.g., stretching, breakup, coagulation, etc.). In this report, we briefly discuss the two main areas of research, and list publications, journals, presentations, proceedings, and lectures for the third year of the grant.

24147 (DOE/ER/13489–4) **The continuum modeling of two-phase systems.** Lahey, R.T. Jr.; Drew, D.A. Rensselaer Polytechnic Inst., Troy, NY (USA). [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13489. Order Number DE90008832. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The four year research program, entitled "The Continuum Modelling of Two-Phase Systems," is intended to advance the state-of-the-art in the two-fluid modeling of steady and transient two-phase flows. During the report period (i.e., the first year) our efforts have focused on the question of well-posedness, that is, the modeling of those closure conditions which yield systems of equations having real eigenvalues, and the implications of having complex eigenvalues. To this end, void wave phenomena were investigated, since the void wave eigenvalues are the ones which become complex, thus leading to ill-posedness. The most significant technical publications that have resulted from the research performed during the report period are attached to this letter. 13 refs.

24148 (SAND–89-0412C) **The thermal response of generic objects in JP-4 pool fires.** Nakos, J.T.; Gill, W.; Keltner, N.R. Sandia National Labs., Albuquerque, NM (USA). [1990]. 33p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9004147–1: 1990 JANNAF propulsion systems hazards meeting, Laurel, MD (USA), 3-5 Apr 1990). Order Number DE90008503. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The measured thermal response of generic objects in engulfing pool fires is presented. The objects include cylinders and flat plates of various sizes and materials. A simple radiation/convection model of the heat transfer from the fire to the object is developed and discussed in light of the experimental data. 11 refs., 20 figs.

24149 Steady thermocapillary flows of thin liquid layers. II. Experiment. Burelbach, J.P. (Fauske & Associates, Inc., 16W070 West 83rd Street, Burr Ridge, Illinois 60521 (USA)); Bankoff, S.G.; Davis, S.H. *Physics of Fluids A (USA)*, 2(3): 322-333 (Mar 1990).

The steady thermocapillary flow of nonvolatile layers, nonuniformly heated from below, is examined. The interactions among viscous forces, thermocapillarity, and hydrostatic effects give rise to the steady-state dimpling of the interface. The steady dimpling of nonuniformly heated silicone–oil layers with mean thicknesses ranging from 0.125 to 1.684 mm is studied experimentally. The temperature distribution in the substrate is monitored by thermocouples and the interface shapes by a mechanical impedance probe. Measured steady shapes and theoretical predictions agree within 20% for moderate heating when the film is not close to rupture. When the heating rate causes the film to "dry out" above the hottest point on the substrate, the long-wave theory delivers a parametric index, involving thermocapillary and hydrostatic effects, which is an excellent predictor of rupture. Nonlinear long-wave theories of the type discussed here have never been tested experimentally, until now. The confirmation of this thermocapillary theory is suggestive of the validity of the previous long-wave analysis [Phys. Fluids A 2, 313 (1990)] of unsteady, evaporating/condensing liquid layers.

24150 Transient mass transfer in parallel passage dehumidifiers with and without solid side resistance. Chuah, Y.K. (Solar Energy Research Institute, Golden, CO 80401 (US)); Norton, P.; Kreith, F. *Journal of Heat Transfer (Transcations of the ASME (American Society of Mechanical Engineers), Series C) (USA)*, 111(4): 1038-1044 (Nov 1989).

Desiccant dehumidifiers have been used in industrial and commerical processes to provide air of lower relative humidity than can be achieved readily with vapor compression equipment. Parallel passage rotary wheel regenerators with silica gel on the passage walls are used as dehumidifiers for air-conditioning applications. This study presents an investigation of transient mass transfer in a parallel passage dehumidifier with a thin layer of silica gel on the passage walls. A two-film resistance model was used to approximate the overall transfer resistance between the process air and the solid desiccant. Isothermal transient mass transfer experiments using parallel passages with silica gel coated walls were conducted and analyzed. It was found that the two-film model agrees with the experimental results within the experimental accuracy. Although only silica gel was used in this study, the results may be extended to other solid desiccants.

24151 Condensation on coherent turbulent liquid jets: Part I—Experimental study. Kim, S. (Department of Mechanical Engineering, Kukmin University, Sungbukku, Seoul, Korea 132 (KR)); Mills, A.F. *Journal of Heat Transfer (Transcations of the ASME (American Society of Mechanical Engineers), Series C) (USA)*, 111(4): 1068-1074 (Nov 1989).

Condensation on coherent turbulent liquid jets was investigated experimentally in order to obtain a data base for the liquid side heat transfer coefficient. Jet breakup was identified by means of high-speed photography. Nozzles were formed from smooth and roughened glass tubes to define the initial turbulence level in the jets. Jet diameters of 3–7 mm and lengths of 2–12 cm were tested at jet velocities of 1.4–12 m/s giving Reynolds numbers 6000–40,000. Viscosity and surface tension were varied by using ethanol, and water from 277–300 K, as test liquids. The Stanton number was found to be essentially independent of jet diameter, but to decrease with length to the power of −0.57, velocity to the power of −0.20, surface tension to the power of −0.30, and viscosity to the power of −0.1.

24152 Condensation on coherent turbulent jets: Part II—A theoretical study. Kim, S. (Department of Mechanial Engineering, Kukmin University, Sungbukku, Seoul, Korea 132 (KR)); Mills, A.F. *Journal of Heat Transfer (Transcations of the ASME (American Society of Mechanical Engineers), Series C) (USA)*, 111(4): 1075-1082 (Nov 1989).

Condensation on coherent turbulent liquid jets was investigated theoretically. The governing conservation equations were obtained using an order of magnitude analysis, and were solved numerically using a finite difference method. The Boussinesq hypothesis was invoked to model turbulent transport. Various eddy diffusivity models, of varying degrees of complexity, were evaluated through comparison with experimental data, and shortcomings noted. An ad hoc model, which allows for axial decay of turbulence by viscosity, and radial decay by both surface tension and viscosity, is shown to be in reasonable agreement with experiment. Numerical solutions were also obtained for laminar jets, and are essentially exact; these solutions are used to give some insight into the nature of the jet heat transfer problem.

24153 Racetrack for competing viscous fingers. Curtis, S.A. (Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh, Pennsylvania 15260 (USA)); Maher, J.V. *Physical Review Letters (USA)*, 63(25): 2729-2732 (18 Dec 1989).

We have observed viscous fingering flow in a Hele-Shaw cell, starting from a carefully prepared initial state of fourteen almost identical fingers. As the flow progresses, killing off thirteen of the fingers on its way to the single-finger steady state, several systematic effects stand out, including (1) a characteristic trajectory for a finger which depends not on its position in the "starting gate" but rather on its final position in the "race" and, most importantly, (2) a cascade of reverse bifurcations, stages in which the number of competing fingers is reduced, typically by a factor of 2.

4205 Materials Testing

Refer also to citation(s) 23725, 23735, 23770, 23777, 23784, 23857, 24148, 24343

24154 (LA–11543-C, pp. 263-297) **Mechanical properties evaluation techniques for anisotropic materials.** Stout, M. Los Alamos National Lab., NM (USA). May 1989. (CONF-880259–Summ.: Metal forming modeling (MFM) subgroup of IMOG, Los Alamos, NM (USA), 23-25 Feb 1988). In *Minutes of the meeting,*

Metal Forming Modeling Subgroup of IMOG, February 1988. Order Number DE89011401. Available from NTIS, PC A14/MF A01.

Many of the materials, to which one applies metal forming techniques to fabricate components, are anisotropic. An example of this is the use of high R-value steels for deep drawing. Another possible effect of anisotropy is in permitting instabilities to form in sheet forming. Because anisotropy can be important, different yield criterion have been proposed to model anisotropic material behavior. In order to use such criteria, special mechanical properties experiments are needed. These experiments generally test materials in complex stress states: balanced biaxial tension, plane strain and shear. Balanced biaxial tension can be achieved with tube experiments, bulge tests, or through thickness compression, plane strain using tubes, tensile samples, or knife edge and channel die experiments, and shear data are obtained by torsion of cylinders, tubes and even rectangles. There are advantages and disadvantages to each of these experiments which are explained in the following viewgraphs. In addition the author also gives examples of the results which he has obtained using these different techniques and shows the sample configurations and fixturing needed to perform these tests.

24155 (ZfK–631) **The importance of the cladding behaviour for the loca analysis.** Boehmert, J.; Linek, J. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1988. 14p. (In German). Order Number DE90621892. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

It can be shown by modelling with the SSYST code and publicated experimental results cladding behaviour may essentially influence the course of a LOCA, especially the oxidation, creeping and bursting of the fuel rod cladding. For that reason, the safety analysis of WWER type reactors based on Zircaloy data may be usefull only for parametric studies, but that will not do on principle. The publicated data of the material behaviour of ZrNb 1 in the high temperature range enables the basic material phenomena to be described. But the modelling of all processes playing an essential part in cladding behaviour under LOCA conditions still requires further experiments to be carried out. (author).

24156 (ZfK–647) **Annealing studies of neutron irradiated reactor pressure vessel steels by positron annihilation.** Brauer, G. (Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic)); Krause, R.; Polity, A. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1988. 11p. Order Number DE90621893. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Annealing studies by positron annihilation (lifetime, Doppler broadening) on unirradiated as well as neutron irradiated Cr-Mo-V reactor pressure vessel steels (Soviet type 15Kh2MFA) are presented. The role of microstructural properties and the formation of irradiation induced carbides are discussed. Possible experiments by other methods to scale the presented evaluations are suggested. (author).

24157 (ZfK–660) **Reactivity effects of small material samples in the assembly SEG.** Seifert, E. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1989. 33p. (In German). Order Number DE90621894. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A description is given of a program for the calculation of the reactivity effects of small but finite material samples. With the help of this program, some questions are investigated arising in the interpretation of sample measurements in the assembly SEG. (author).

24158 **Selectively breaking the O–H bond in HOD.** Vander Wal, R.L. (Department of Chemistry, University of Wisconsin-Madison, Madison, Wisconsin 53706 (US)); Scott, J.L.; Crim, F.F. *Journal of Chemical Physics (USA)*, 92(1): 803-805 (1 Jan 1990).

Vibrationally mediated photodissociation of HOD, in which one photon excites an O–H stretching vibration and another photon dissociates the vibrationally excited molecule, preferentially breaks the O–H bond for some photolysis wavelengths. Excitation of the third O–H stretching overtone ($4\nu_{OH}$) of HOD followed by photolysis with a 239.5 or 266 nm photon produces at least 15 times more OD than OH product, as determined by laser induced fluorescence detection of both species. Dissociation of HOD($4\nu_{OH}$) with a 218.5 nm photon produces comparable amounts of OH and OD fragments. This large selectivity and strong dependence on the wavelength of the photolysis photon is consistent with qualitative models of vibrationally mediated photodissociation and with recent calculations.

4210 Combustion Systems

Refer also to citation(s) 23425, 23436, 23870

24159 (N–90-13749) **Presented at the 28th Aerospace Sciences Meeting, Reno, NV, 8-11 January 1990.** Raju, M.S.; Willis, E.A. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1989. 37p. (NASA-TM–102469;E–5249;NAS–1.15:102469;AIAA–90-0643;CONF-900153–: 28. AIAA aerospace sciences meeting, Reno, NV (USA), 8-11 Jan 1990). Available from NTIS, PC A03/MF A01.

A new computer code was developed for predicting the turbulent, and chemically reacting flows with sprays occurring inside of a stratified charge rotary engine. The solution procedure is based on an Eulerian Lagrangian approach where the unsteady, 3-D Navier-Stokes equations for a perfect gas mixture with variable properties are solved in generalized, Eulerian coordinates on a moving grid by making use of an implicit finite volume, Steger-Warming flux vector splitting scheme, and the liquid phase equations are solved in Lagrangian coordinates. Both the details of the numerical algorithm and the finite difference predictions of the combustor flow field during the opening of exhaust and/or intake, and also during fuel vaporization and combustion, are presented.

24160 (NILU/OR–59/88) **Air pollution and environmental impacts from a planned incineration plant for wastes and bark in Namsos.** Braathen, O.A.; Boehler, T.; Berntsen, T. Norsk Inst. for Luftforskning, Lillestroem (Norway). Nov 1988. 33p. (In Norwegian). Order Number DE90760287. Available from NTIS (US Sales Only), PC A03/MF A01.

The report presents a consequence analysis on air pollution and environmental impact for a planned incineration plant in Namsos (Norway). Two alternative locations are investigated. The annual capacity of the plant is calculated to be about 6000 tons of refuse and 5000 tons of bark. The various chemical effluents are analysed and the volumes of discharged chemicals are compared in accordance with recommended limit values. 10 figs., 8 tabs, 14 refs.

4230 Marine Engineering

Refer also to citation(s) 23525, 23526

24161 (DTH-ISVA-Series Paper–45) **Experimental investigation of turbulent oscillatory boundary layers.** Lykke Jensen, B. Danmarks Tekniske Hoejskole, Lyngby (Denmark). Inst. for Stroemningsmekanik og Vandbygning. Dec 1988. 161p. Order Number DE90760239. Available from NTIS (US Sales Only), PC A08/MF A01.

An experimental investigation of the turbulent purely oscillating boundary layer over both smooth and rough walls has been carried out. Mean and turbulence quantities were measured with a Laser Doppler Anemometer in both the streamwise and in the direction perpendicular to the wall, and smooth-wall bed-shear-stress was measured directly with a hot-film proble. The measurements covered Reynolds numbers up to Re = 6 x 106, and in the case of a rough bed, values of the parameter a/ks from 400 - 3700. The properties of the smooth-wall boundary layer at the uppermost Re-number which could be achieved, Re = 6 x 106, are discussed in detail, and it is found that the flow behaviour for most of the flow cycle matches the behaviour found in steady flows. The same similarity was found for rough-wall flows at high values of a/ks. For smooth-bed boundary layer flows the effect of the Reynolds number is discussed in greater detail, and it is demonstrated that the boundary layer properties change markedly with Re-numbers. This analysis also covers the laminar-to-turbulent transition phenomena, and it was found that this transition process covers a wide range of Re-numbers. For rough-bed boundary layer flows, the effect of the parameter a/ks is examined, and it was found that this effect basically is a relative boundary layer thickness (delta/ks) effect. Also

the effect of the roughness Reynolds number (ksm+) is investigated and the experimental results indicate that the laminar-to-turbulent transition interacts with the smooth-to-rough wall transition in a complex manner if, ksm+ < 70 and Re < 6 x 106. (author) 58 refs.

24162 (DTH-ISVA-Series Paper–47) **A boundary integral equation model for the development of non-linear water waves and their interaction with structures.** Skourup, J. Danmarks Tekniske Hoejskole, Lyngby (Denmark). Inst. for Stroemningsmekanik og Vandbygning. Jun 1989. 168p. Order Number DE90760238. Available from NTIS (US Sales Only), PC A08/MF A01.

A computational model based on potential theory for the development of highly non-linear water waves and their interaction with fixed structures has beenestablished by use of a Bondary Intergral Equation Method combined with a Lagrangian time stepping procedure for the free water surface (based on the fully non-linear boundary conditions there). The computational model is two-dimensional (2-D), but the formulation and the basic ideas can be extended to three spatial dimensions (3-D). The computational model (which is space periodic) enables one to periods, and to compute the breaking of waves. For the computation of a breaking wave we can follow the tip of the jet almost until it touches the free water surface below it, and the computations are performed without any artificial smoothing. Structures (that are cylindrical and with a horizontal axis parallel with the wave front) are introduced into the computational domain, and the wave forces on those are calculated provided that effects of separation are neglected, however, when the Keulegan-Carpentet number of the wave-straucture interaction is small, and the structure does not have any sharp corners, then the forces due to separation are immaterial compared to the inertia forces, which may be computed from potential theory. A new method is developed for following the traces of the particle orbits within the fluid domain, and the influence on the particle motion from submerged horizontal cylindrical structures is visualized by a number of computational examples. It is found that the orbital motion of the water particles is affected by the cylinder, and for particles close to the cylinder it is found that their paths follow the contour of the cylinder. Computations covering several wave periods reveal that there is a circulation of water around the cylinder, with a direction of motion the same as the orbital motion of the water particles. (AB) 81 refs.

24163 (NEI-NO–102) **Installation and maintenance of subsea production system.** Norsk Petroleumsforening, Oslo (Norway). 1987. 421p. (In Norwegian). (CONF-8703333–: Installation and maintenance of subsea production system, Haugesund (Norway), 16-18 Mar 1987). Order Number DE90760265. Available from NTIS (US Sales Only), PC A18/MF A01.

The collected papers given at a conference deal with the various development projects concerning subsea production systems on the Norwegian continental shelf. In addition two types of subsea production systems in Brazil are presented. Separate abstracts are prepared for all of the papers. 145 figs., 14 tabs.

24164 (NEI-NO–102, pp. 20) **Survey of systems/techniques.** Lindaas, J.C. Norsk Petroleumsforening, Oslo (Norway). 1987. (In Norwegian). (CONF-8703333–: Installation and maintenance of subsea production system, Haugesund (Norway), 16-18 Mar 1987). In *Installation and maintenance of subsea production systems, Haugesund (Norway), 16-18 Mar 1987.* Order Number DE90760265. Available from NTIS (US Sales Only), PC A20/MF A01.

The present paper gives a survey of systems/techniques used in offshore development. Following aspects are considered: background for the use of subsea production systems, development, components, maintenance strategies/methods,development trends. 6 figs.

24165 (NEI-NO–102, pp. 20) **Planning and installation of subsea production systems on the Gullfaks field.** Inderberg, O. (Statoil, Stavanger (Norway)). Norsk Petroleumsforening, Oslo (Norway). 1987. (In Norwegian). (CONF-8703333–:). In *Installation and maintenance of subsea production systems, Haugesund (Norway), 16-18 Mar 1987.* Order Number DE90760265. Available from NTIS (US Sales Only), PC A20/MF A01.

The paper presents the Gullfaks A subsea production systems on the Norwegian continental shelf. The Gullfaks A field consists of four completed wells and a water injection system. Remote controlled tools and systems are developed for deep water operation and maintenance. 8 figs.

24166 (NEI-NO–102, pp. 21) **Experiences from installation and maintenance of subsea production systems in Brazil.** Haehre, T.F.; Molinari, E.A. Norsk Petroleumsforening, Oslo (Norway). 1987. (In Norwegian). (CONF-8703333–: Installation and maintenance of subsea production system, Haugesund (Norway), 16-18 Mar 1987). In *Installation and maintenance of subsea production systems, Haugesund (Norway), 16-18 Mar 1987.* Order Number DE90760265. Available from NTIS (US Sales Only), PC A20/MF A01.

The paper deals with two major subsea production systems in Brazil. The first one described here is a diverless lay-away flowline connector system developed for the completion of a safelife well on the Marimba field. The water depth is 412 m. Data on the duration of each of the stages of well completion and -installation both for the x-mas tree and flowlines are presented and commented. The second one of the systems concerned are the installation and operation of a subsea manifold on the Linguado field. The manifold is designed for handling wet gas from ten satelite wells. Data on the operation of the manifold are presented and commented. 10 figs.

24167 (NEI-NO–102, pp. 13) **Intervention and tool.** Roennevig, C.M. Norsk Petroleumsforening, Oslo (Norway). 1987. (In Norwegian). (CONF-8703333–: Installation and maintenance of subsea production system, Haugesund (Norway), 16-18 Mar 1987). In *Installation and maintenance of subsea production systems, Haugesund (Norway), 16-18 Mar 1987.* Order Number DE90760265. Available from NTIS (US Sales Only), PC A20/MF A01.

The paper presents a heave-compensating ruming tool (catyoke). The tool is designed for being used for the connection/ disconnection of modules on the sea bed and also in connection with drilling operations. 5 figs.

24168 (NEI-NO–102, pp. 36) **Surface support vessel for UVPS.** Knutsen, J.O. Norsk Petroleumsforening, Oslo (Norway). 1987. (In Norwegian). (CONF-8703333–: Installation and maintenance of subsea production system, Haugesund (Norway), 16-18 Mar 1987). In *Installation and maintenance of subsea production systems, Haugesund (Norway), 16-18 Mar 1987.* Order Number DE90760265. Available from NTIS (US Sales Only), PC A20/MF A01.

The paper identifies the different work tasks for a standard gas or oil subsea field and the candidate surface support vessel for different tasks on the field during the field production life. Emphasis has been laid down in order to identify the vessel cost and the prospectives of reducing the rather cost ineffective use of large and comprehensive vessel spreads for even light equipment installation. 13 figs.

24169 (NEI-NO–102, pp. 10) **Use of robots in UVPS.** Lindstad, A. Norsk Petroleumsforening, Oslo (Norway). 1987. (In Norwegian). (CONF-8703333–:). In *Installation and maintenance of subsea production systems, Haugesund (Norway), 16-18 Mar 1987.* Order Number DE90760265. Available from NTIS (US Sales Only), PC A20/MF A01.

The paper discusses new concepts concerning the development of subsea production systems by use of remote operational vehicles. 7 figs.

24170 (NEI-NO–102, pp. 27) **Are manned submarine vessels a real alternative.** Skyberg, Oe. Norsk Petroleumsforening, Oslo (Norway). 1987. (In Norwegian). (CONF-8703333–: Installation and maintenance of subsea production system, Haugesund (Norway), 16-18 Mar 1987). In *Installation and maintenance of subsea production systems, Haugesund (Norway), 16-18 Mar 1987.* Order Number DE90760265. Available from NTIS (US Sales Only), PC A20/MF A01.

The paper discusses a submarine concept designed for maintaining subsea production systems or the like. The extensiveness of application and operation modes for such types of services are

evaluated. A number of 10-15 crewmembers are needed in such types of operations. Costs are considered. 5 figs., 11 tabs.

24171 (NEI-NO–102, pp. 15) **Can use of divers be eliminated.** Sandvig, G.U. (Saga Petroleum a.s., Hoevik (Norway)). Norsk Petroleumsforening, Oslo (Norway). 1987. (In Norwegian). (CONF-8703333–: Installation and maintenance of subsea production system, Haugesund (Norway), 16-18 Mar 1987). In *Installation and maintenance of subsea production systems, Haugesund (Norway), 16-18 Mar 1987.* Order Number DE90760265. Available from NTIS (US Sales Only), PC A20/MF A01.

The present paper discusses diverless intervention tasks regarding installation, inspection, maintenance, and repair of offshore installations. The installations concerned are offshore platforms, subsea installations, and pipelines. The status of to day and future prospects in this field are given. 4 figs.

24172 (NEI-NO–102, pp. 28) **Towards the year 2000 with "POSEIDON".** Torp, T.A. Norsk Petroleumsforening, Oslo (Norway). 1987. (In Norwegian). (CONF-8703333–: Installation and maintenance of subsea production system, Haugesund (Norway), 16-18 Mar 1987). In *Installation and maintenance of subsea production systems, Haugesund (Norway), 16-18 Mar 1987.* Order Number DE90760265. Available from NTIS (US Sales Only), PC A20/MF A01.

The paper discusses the development of the Norwegian continental shelf towards the year 2000. Various concepts on subsea production systems are discussed. Topics are as follow: technological advance in the 1990's; technical trends; costs and possibilities; technological bottlenecks; installation and operation; social consequences. 15 figs.

24173 (NEI-NO–102, pp. 25) **DIMOS - a maintenance concept from studies to fabrication.** Skogen, T. (Kongsberg Offshore Systems a.s., (Norway)). Norsk Petroleumsforening, Oslo (Norway). 1987. (In Norwegian). (CONF-8703333–: Installation and maintenance of subsea production system, Haugesund (Norway), 16-18 Mar 1987). In *Installation and maintenance of subsea production systems, Haugesund (Norway), 16-18 Mar 1987.* Order Number DE90760265. Available from NTIS (US Sales Only), PC A20/MF A01.

The paper presents a project dealing with the DIMOS (Diverless Installable and Maintainable Oil Production System) concept designed for water depths of 600 m. The concept includes the subsea manifold structure and the maintenance system for the same. Some of the components in the system are being built and tested. The various valve- and control units are grouped into individual modules. Each of the modules can easily be disconnected for repair and replaced by new modules. The manifold centre is designed for TFL (Through Flow Line) service of satelite wells. 15 figs.

24174 (NEI-NO–102, pp. 37) **Potential use of the SAS (Subsea Atmospheric System) concept in connection with the development of Statfjord Nord.** Erstad, T. Norsk Petroleumsforening, Oslo (Norway). 1987. (In Norwegian). (CONF-8703333–: Installation and maintenance of subsea production system, Haugesund (Norway), 16-18 Mar 1987). In *Installation and maintenance of subsea production systems, Haugesund (Norway), 16-18 Mar 1987.* Order Number DE90760265. Available from NTIS (US Sales Only), PC A20/MF A01.

The paper presents the SAS (Subsea Atmospheric System) concept designed for being used in connection with the development of the Statfjord Nord field on the Norwegian continental shelf. The concept includes a framed drill template structure consisting of a number of ten sectional units and one centre-positioned subsea work enclosure. Nine of the units are equipped with wellheads and one is servicing as a pipe bundle connector between the wellheads mentioned and an offshore platform or a buoyant processing unit. The SAS concept is designed for diverless installation procedures on water depths between 250 and 800 m. and the space of 10-20 km between the structure and the basic platform. The production capacity of the system is calculated to be about 75000 barrels/day with a corresponding water-injection capacity of 90000 barrels/day. 23 figs.

24175 (NEI-NO–102, pp. 39) **"Petrojarl 1" on Oseberg - the first buoyant production concept on the Norwegian continental shelf.** Hermansen, B.A. (Norsk Hydro a.s., Hoevik (Norway)). Norsk Petroleumsforening, Oslo (Norway). 1987. (In Norwegian). (CONF-8703333–: Installation and maintenance of subsea production system, Haugesund (Norway), 16-18 Mar 1987). In *Installation and maintenance of subsea production systems, Haugesund (Norway), 16-18 Mar 1987.* Order Number DE90760265. Available from NTIS (US Sales Only), PC A20/MF A01.

The paper presents a development concept for the Oseberg fields on the Norwegian continental shelf. The distinctive condition of the reservoir together with the development of reliable field equipment show the need for the use of comprehensive calculation methods in the evaluation of optimal drainage. Mathematical models are used in the evaluation. The concept includes a fiord test program comprising the use of the "Petrojarl 1" test/production vessel, a subsea production system with a rigid or flexible riser system, and the "Petroskald" shuttle tanker. The concept also includes the final connection of the "Petrojarl 1" production system to the completed wells on the Oseberg field. The system was put into operation in 1986. The experiences gained from the first buoyant test/production system in Norway show that the concept has a great potentiality regarding successful development of fields in the North Sea. 14 figs., 3 tabs.

24176 (NEI-NO–102, pp. 23) **General description of TOGI (Troll-Oseberg Gas Injection).** Norsk Petroleumsforening, Oslo (Norway). 1987. (CONF-8703333–: Installation and maintenance of subsea production system, Haugesund (Norway), 16-18 Mar 1987). In *Installation and maintenance of subsea production systems, Haugesund (Norway), 16-18 Mar 1987.* Order Number DE90760265. Available from NTIS (US Sales Only), PC A20/MF A01.

The paper deals with the TOGI (Troll-Oseberg Gas Injection) project. The project concerns the method of changing the reservoir pressure maintenance program from water injection to gas injection on the Oseberg field on the Norwegian Continental Shelf. The required volume of gas to secure the daily average supply to Oseberg is calculated to be 7.1x10^6 Sm^3/d. The total gas volume is about 25-30x10^9 Sm^3. The TOGI project consists of developing the following production systems: well cluster system on Troll; pipelines between Troll and Oseberg; systems at the Oseberg platform A and B designed for gas import, control and monitoring of the well cluster system, and storage and pumping of chemicals to Troll; Intervention system for operation and maintenance. 7 figs.

4260 Components, Electron Devices and Circuits

Refer also to citation(s) 23627, 23628, 23772, 23789, 23903, 23992, 23999, 24225, 24281, 24316, 24326, 24334, 24341, 24842, 25195

24177 (AD-A–215389/8/XAB) **Frequency chirp of a low-pressure hybrid TE CO_2 laser.** Eng, R.S.; Grimm, J.G.; Freed, C.; O'Donnell, R.G. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. 1989. 14p. (MS–8144). Available from NTIS, PC A03/MF A01.

Pub. in SPIE (Society of Photo-Optical Instrumentation Engineers), Vol. 1103, 32-44(1989).

The frequency chirp in the output of a hybrid TE CO_2 laser has been measured using a heterodyne technique. Due to the low operating pressure of about 35 Torr, laser kinetic and hydrodynamic processes differ considerably in time scale from those in regular TEA CO_2 lasers. The chirps in laser pulses up to 150 microsec long could not be described adequately with existing theories. Almost complete cancellation of the laser chirp was achieved by appropriate use of acousto-optic modulators external to the hybrid TE CO_2 laser. The operating and output characteristics of this laser and other parameters related to chirp will be discussed.

24178 (AD-A–215463/1/XAB) **Phenomenological loss equivalence method for planar quasi-tem transmission lines using a thin normal conductor or superconductor. Technical report.** Lee, H.Y.; Itoh, T. Texas Univ., Austin, TX (USA). Microwave Lab.

Dec 1989. 57p. (MW–89-P-6). Available from NTIS, PC A04/MF A01.

This technical report presents a simple and practical method for the conductor loss calculation over a wide range of field penetration which can be applied to both normal-state and superconducting transmission lines. The calculated results for microstrip lines and coplanar waveguides using normal conductors and superconductors agree very well with the data obtained using the finite element method, the Monte-Carlo method, and experimental measurements. Because of the calculation simplicity, this method is very suitable for computer-aided design of monolithic microwave and millimeter-wave integrated circuits.

24179 (AD-A–215511/7/XAB) **Noise in an acoustic-optic modulated laser source.** Kachelmyer, A.L.; Eng, R.S. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. 1989. 18p. (MS–8238). Available from NTIS, PC A03/MF A01.

Pub. in SPIE (Society of Photo-Optical Instrumentation Engineers), Vol. 1103, 92-108(1989).

This paper considers the measurement of amplitude modulation (AM) and phase modulation (PM) noise in a tunable CO_2 laser source. Theoretical and experimental heterodyned output power spectrums are used to evaluate the quality of the acousto-optically tuned source.

24180 (AD-A–215514/1/XAB) **Microchip lasers.** Zayhowski, J.J.; Mooradian, A. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. May 1989. 9p. (JA–6280). Available from NTIS, PC A02/MF A01.

Pub. in Proceedings of the OSA (Optical Society of America) Topical Meeting on Tunable Solid State Lasers, 288-294(1-3 May 1989).

Tunable, single-frequency, Nd based microchip lasers have been piezoelectrically frequency modulated over several hundred MHz at rates from dc to 25 MHz. They have also been gain-switched to produce pulses shorter than 120 ps. CW thresholds of less than 0.7 mW have been observed at room temperature, with slope efficiencies of greater than 46%. Single-frequency, diode-pumped operation has been maintained at output powers greater than 51 mW. Heterodyne measurements show an instrument-limited linewidth of less than 5 kHz. Microchip lasers demonstrate ways to greatly reduce the cost and complexity of fabricating small lasers and electro-optic devices.

24181 (JINR–13-88-636) **19-channel light optical link for data transmission using a multiplexer.** Romanov, Yu.I. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1988. 10p. (In Russian). Order Number DE90622047. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

An noise-proof fiber optical transmission line using a multiplexer is described. The rate of data transfer is 2.5 MBIT/s, the number of independent inputs/outputs is 19, the levels of input/output signals are TTL, and the type of a serial code is MANCHESTER. The maximum length of the optical line is 630 m. 11 refs.; 7 figs.

24182 (JINR-R–10-88-505) **A multi-stop time-to-code converter.** Zinov, V.G.; Selikov, A.V. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 7p. (In Russian). Order Number DE90622044. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to Prib. Tekh. Eksp.

A multi-stop time-to-code converter of the counting-pulse type is described. The device allows one to determine time position of 1-15 Stop pulses with regard to the start signal with a resolution of 5 ns and dead time of 40 ns. The maximum frequency of a clock-period series is 200 Hz. The differential non-linearity of the converter at the maximum clock frequency is $\pm$ 0.5%. The output code of the time interval is of 14 bits. The device is made as a CAMAC block of a unit width. 7 refs.; 4 figs.

24183 (LA–11778-MS) **The RAP unit: A remote autoranging picoammeter.** Martin, E.R. (Los Alamos National Lab., NM (USA)); Bennion, K.M.; Jones, D.F. Los Alamos National Lab., NM (USA). Mar 1990. 95p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE90007711. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

A digital instrument for remote acquisition of low-level current measurements is described. Primarily designed for operation with ionization chambers, this instrument provides the capability of local or remote operation over the current range from 10^{-11} to 10^{-4} A. It is capable of autoranging operation, or it can be placed in a "hold" mode where the range is specified. The digital communication link is an optically-isolated 60-mA current loop for noise-free operation, and the unit can be daisy-chained for multiple-unit communication. 10 figs.

24184 (N–90-13772) **Development of mid-infrared solid state lasers for spaceborne lidar. Final report, 13 April 1988-15 October 1989.** Whitney, D.A.; Kim, K.H. Hampton Inst., VA (USA). Oct 1989. 52p. (NASA-CR–183290;NAS–1.26:183290). Available from NTIS, PC A04/MF A01.

Laser performance of Ho(3+):Tm(3+):Cr(3+):YAG crystals was investigated under both Cr:GSAG laser and flashlamp pumping. A flashlamp pumped Cr:GSAG laser was built to simulate high power quasi-CW laser diode pumping of a 2.1 micrometer holmium laser. The 2.1 micrometer output laser energy exceeded more than 14 mJ, the highest value reported to date under laser pumping near 785 nm. This was obtained in a pulse length of nearly 650 microsec from a 3 x 3 mm Ho:Tm:Cr:YAG rod by using the flashlamp-pumped Cr:CSAG laser as a pumping source at the diode laser wavelength, 785 micrometers. In addition, Ho:Tm:Cr:YAG crystals with various Tm(3+) concentrations were evaluated for flashlamp-pumped normal mode and Q-switched 2.1 micrometer laser operations under a wide variety of experimental conditions in order to understand internal dynamic processes among the ions and to determine an optimum lasing condition. An increase of the laser slope efficiency was observed with the increase of the Tm(3+) concentration from 2.5 to 4.5 atomic percent. The thermal dependence of the laser performance was also investigated. Q-switched laser output energies corresponding to nearly 100 percent of the normal-mode laser energies were obtained in a strong single spike of 200 ns pulse length by optimizing the opening time of a lithium niobate Q-switch.

24185 (N–90-14583) **Theoretical studies of solar lasers and converters. Progress report, 15 May-31 December 1989.** Heinbockel, J.H. Old Dominion Univ., Norfolk, VA (USA). Jan 1990. 47p. (NASA-CR–186194;NAS–1.26:186194). Available from NTIS, PC A03/MF A01.

The research described consisted of developing and refining the continuous flow laser model program including the creation of a working model. The mathematical development of a two pass amplifier for an iodine laser is summarized. A computer program for the amplifier's simulation is included with output from the simulation model.

24186 (SAND–86-1397) **SANDUS [SANdia Digital Underground System]: MA164 digital data acquisition system specifications.** Opalka, J.M. Sandia National Labs., Albuquerque, NM (USA). Jan 1990. 90p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC04-76DP00789. Order Number DE90007901. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The SANDUS will accept data from up to 128 unique analog channels and up to 88 eight bit digital channels. This system is capable of simultaneously conditioning, amplifying, digitizing, and internally storing the data from all channels. The channels record analog signals with amplitudes in the range of 1 mV to 10 V at frequencies from dc to 100 KHz, with accuracy to 99.976%, and/or signals with amplitudes in the range of 8 mV to 4 V at frequencies from dc to 10 MHz, with accuracy to 99.61%. The digitized data is continually output to a remote location for processing. The entire system may be controlled locally, remotely, or automatically in adverse electrical and environmental locations. Appendix 2 has been included to facilitate the withdrawal of any system drawing from the Sandia Film Bank. 16 figs.

24187 (UCID–21941) **Program CICC [cable-in-conduit conductors], flow and heat transfer in Cable in Conduit Conductors—user's manual.** Wong, R.L. Lawrence Livermore National Lab., CA (USA). 14 Feb 1990. 64p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. Order

Number DE90007924. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report is the user's manual for program CICC and it's graphics postprocessor, CICCP. CICC was written for use in the thermofluids design of the cryogenic superconducting magnets which utilize helium-cooled, cable-in-conduit conductors (CICC). The program models the transient thermodynamic and fluid-dynamic system response to the occurrence of normal-zone heating in the superconductor. References 1 and 2 have previously been written describing the equations used in the program, the solution method, and the experimental verification. 22 figs., 1 tab.

24188 (UCRL–15684) **Research and development of Frit type edge cladding for GSGG laser crystals: Final technical report, July 1984–January 1985.** Izumitani, T. (Hoya Optics, Inc., Fremont, CA (USA)); Meissner, H.E.; Toratani, H.; Nakajima, S. Lawrence Livermore National Lab., CA (USA); Hoya Optics, Inc., Fremont, CA (USA). 30 Jan 1985. 46p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008530. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

A glass compositional area has been defined in the system CuO-PbO-Bi_2O_3-Al_2O_3-SiO_2 with thermal expansion coefficients of about 82–84 $\times$ 10^{-7}/°C and refractive indices at 1.06 micron of about 1.93. Absorption coefficients are adjustable with CuO levels. These properties are required for a cladding glass for the edges of GSGG crystal slabs. Experiments with GSGG disks of 6 and 14 mm dia. have resulted in coatings of strong adhesion with glass crystal interfaces which are free of bubbles or devitrification. 4 refs., 11 figs., 14 tabs.

24189 (UCRL–21275) **Laser line transport with refraction: Final report.** Kunasz, P. Lawrence Livermore National Lab., CA (USA). 9 Aug 1989. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008683. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Extensive studies have been completed of numerical methods for the treatment of refraction in laser line transport. A stable method which provides acceptable accuracy now resides in the three- dimensional laser transport code BEAM3. By way of review, the numerical method employed by BEAM3 is an extension to three dimensions of a technique tested extensively in a one-dimensional model of a laser rod. At each time step, this method involves sweeping back and forth along the rod axis z, solving for the forward propagating intensity while holding the back-propagating beam fixed. The sweeps continue until convergence is achieved. On each sweep, the nonlinear transport equation is solved by the method of Newton Raphson, for the intensity J_k, at each slice z_k along the rod. At slice z_k, on a sweep over increasing values of k, the upwind intensity value is known at z_{k-1}, z_{k-2}, $\cdots$, z_2, z_1. To solve the transport equation at z_k the ray of propagation is extended upwind until it intersects either the coordinate boundary z_{k-1}, or the previous time value, ct_{n-1}. Therefore, for sub-Courant time steps, the upwind conditions couple to the unknown slice as well as the upwind slice.

24190 (UCRL–102739) **Bragg resonator for selective feedback in overmoded oscillators.** Chong, C.K. (California Univ., Los Angeles, CA (USA). Dept. of Electrical Engineering); Razeghi, M.M.; McDermott, D.B.; Luhmann, N.C. Jr.; Caplan, M.; Kulke, B. Lawrence Livermore National Lab., CA (USA). 23 Jan 1990. 10p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Contract F30602-87-C-0201;DAAL03-87-K-0139;86-0199;N00014-87-K-2 (CONF-900140–15: SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition, Los Angeles, CA (USA), 15-19 Jan 1990). Order Number DE90007853. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The theory of a Bragg reflector composed of periodic cylindrically symmetric corrugations symmetric corrugations is presented. For a wave satisfying the Bragg condition, the corrugations can provide a reflection of nearly unity through the principles of constructive interference, resulting in a frequency selective resonator. It is found that a maximum allowable value exists for the corrugation amplitude. 4 refs., 7 figs.

24191 Analysis of rib waveguides and couplers by the propagating beam method. Feit, M.D. (Lawrence Livermore National Laboratory, P.O. Box 808, Livermore, California 94550 (US)); Fleck, J.A. Jr. *Journal of the Optical Society of America, Part A: Optics and Image Science (USA)*, 7(1): 73-79 (Jan 1990). DOE Contract W-7405-ENG-48.

The propagating beam method (PBM) is known to be an accurate tool for modeling propagation in waveguides with graded-index profiles. Intuition suggests, on the other hand, that the PBM is inappropriate for waveguides such as rib waveguides that exhibit refractive-index discontinuities. We demonstrate here that the PBM is indeed applicable to rib waveguides, although extremely small longitudinal integration steps may be required. Comparison with other numerical methods for calculating mode indices for single waveguides shows good agreement. The assessment of accuracy for modeling rib-waveguide directional couplers, on the other hand, is less certain because of a general lack of consistency among the various methods used in the comparison.

24192 Ultrashort-pulse energy-extraction measurements in XeCl amplifiers. Taylor, A.J. (Laser Science and Applications Group, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (US)); Gosnell, T.R.; Roberts, J.P. *Optics Letters (USA)*, 15(2): 118-120 (15 Jan 1990).

Energy extraction in XeCl discharge amplifiers is examined experimentally and theoretically for 0.16-, 3.0-, and 600-psec pulse durations. Saturation energies of 1.0, 1.0, and 2.5 mJ/Cm^2, respectively, are measured. When nonsaturable loss is included in the analysis the values of the saturation energies increase to 1.35, 1.35, and 3.0 mJ/cm^2, respectively. A significant decrease in the effective small-signal gain is observed as the pulse duration decreases to the bandwidth limit, in agreement with a simple coherent pulse-propagation calculation.

24193 Supercontinuum generation at 248 nm using high-pressure gases. Gosnell, T.R. (Laser Science and Applications Group, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (US)); Taylor, A.J.; Greene, D.P. *Optics Letters (USA)*, 15(2): 130-132 (15 Jan 1990).

Supercontinuum generation at 248 nm has been observed, for the first time to the author's knowledge, by focusing subpicosecond laser pulses into neon, argon, and krypton gases at pressures as high as 40 atm. In the case of neon, the continuum spans a wavelength range reaching from the visible to well into the vacuum ultraviolet. In the range of 200 to 300 nm, the continuum obtained by using krypton is of particularly high quality and therefore well suited to applications in ultrafast spectroscopy in this wavelength range.

24194 Multilayer $YBa_2Cu_3O_x$-$SrTiO_3$-$YBa_2Cu_3O_x$ films for insulating crossovers. Kingston, J.J. (Department of Physics, University of California, Berkeley, CA (US)—Center for Advanced Materials, Materials and Chemical Sciences Division, Lawrence Berkeley Laboratory, 1 Cyclotron Road, Berkeley, California 94720); Wellstood, F.C.; Lerch, *Applied Physics Letters (USA)*, 56(2): 189-191 (8 Jan 1990). DOE Contract AC03-76SF00098.

We describe our procedure for fabricating $YBa_2Cu_3O_x$-$SrTiO_3$-$YBa_2Cu_3O_x$ thin-film trilayer structures. Each film is grown *in situ* by excimer laser deposition onto a heated (100)MgO substrate. The geometrical configuration of each layer is defined by a metal mask; the vacuum chamber is opened between depositions to allow the targets and masks to be changed. The lower and upper $YBa_2Cu_3O_x$ films in the best trilayer structure had transition widths of 1 and 3 K (10–90%), respectively, and transition temperatures (zero resistance) of 87 K. The resistance between the $YBa_2Cu_3O_x$ films at 77 K was 10^8 Ω for an overlapping area of 0.2 mm^2, corresponding to a $SrTiO_3$ resistivity of 4×10^9 Ω cm.

24195 Treatment of the spectrum of squeezing based on the modes of the universe. I. Theory and a physical picture. Gea-Banacloche, J. (Center for Advanced Studies and Department of Physics and Astronomy, University of New Mexico, Albuquerque, New Mexico 87131 (US)—Max-Planck-Institut fuer Quantenoptik,

D-8046 Garching bei Muenchen, West Germany); Lu, N.; Pedrotti, L.M. *Physical Review, A (General Physics) (USA),* 41(1): 369-380 (1 Jan 1990).

For a leaky cavity driven by an active medium, we clarify the connection between the concepts of single-quasimode squeezing (for the intracavity field) and spectral squeezing (for the input and output fields). Our analysis is based on a rigorous construction of the Fox-Li quasimodes of an empty cavity by a superposition of the true modes of a perfect, large (infinitely large in the limit) cavity which fully subsumes the leaky cavity. To illustrate the physical importance of spectral squeezing (as defined here and as used by other authors), we consider a novel model of a microscopic system that is sensitive to the generalized quadratures of the field. We obtain a simple picture of the reasons why the quantum-noise reduction is in general different inside and outside the cavity. An important special case of our picture is that if the *intracavity* field is perfectly squeezed, then the *output* field shows no squeezing at all. Our considerations apply to a wide class of systems, examples of which are discussed in the companion paper.

24196 Treatment of the spectrum of squeezing based on the modes of the universe. II. Applications. Gea-Banacloche, J. (Center for Advanced Studies and Department of Physics and Astronomy, University of New Mexico, Albuquerque, New Mexico 87131 (US)— Max-Planck-Institut fuer Quantenoptik, D-8046 Garching bei Muenchen, West Germany); Lu, N.; Pedrotti, L.M *Physical Review, A (General Physics) (USA),* 41(1): 381-387 (1 Jan 1990).

In the preceding paper we developed a formalism based on the true modes of the universe containing a leaky cavity to analyze the relationship of quantum noise inside that cavity to that outside. We illustrate this formalism here by studying several active systems. We analyze both an ordinary laser and a laser operating in the phase-locked regime. We calculate the extracavity quadrature variances for the phase-locked laser and find that the spectrum of noise reduction in the squeezed quadrature is Lorentzian. Our formalism is also applied to a two-photon correlated-spontaneous-emission laser. We find the familiar result that with 50% squeezing in the phase quadrature of the field *inside* the cavity, one has nearly 100% phase squeezing *outside* the cavity. However, under different conditions the phase quadrature of the *intracavity* field is nearly perfectly squeezed, but the *extracavity* field shows almost no squeezing in its phase quadrature. We also analyze the effect of finiteness of measurement time on the extracavity quadrature variances.

24197 Transient state of a bunched electron beam subject to resistive-wall instability. Rangarajan, G. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742 (USA)); Chan, K.C.D. *Physical Review, A (General Physics) (USA),* 41(1): 333-342 (1 Jan 1990).

This paper analyzes the transient state of a bunched electron beam traversing a narrow beam pipe under the influence of transverse resistive-wall effects. Because the electron beam in the wigglers of future free-electron lasers (FEL's) is required to travel in pipes with small diameters, this study is relevant in determining the beam stability in these FEL's. The analysis is restricted to the case in which the first mode dominates. First, an integral representation of the single-mode solution is obtained. Second, the transient-state solution is obtained for the case in which the focusing force dominates the resistive-wall force. The maximum transient amplitude is derived for the case in which a single bunch is off-axis. Third, this result is used to compute the maximum transient amplitudes when the bunches enter the system with random and with equal initial displacements, respectively. These analytic expressions of maximum transient amplitudes are useful in predicting when the transient could become significant. They are compared with earlier derivations and with numerical simulations. These expressions are also applied to various proposed FEL's. Results showed that the transverse resistive-wall instability could not pose a problem in the operation of these FEL's.

24198 Reactive quenching of two-photon excited xenon atoms by Cl_2. Bruce, M.R. (Department of Physics, The University of Texas at Austin, Austin, Texas 78712 (US)); Layne, W.B.; Meyer, E.; Keto, J.W. *Journal of Chemical Physics (USA),* 92(1): 420-427 (1 Jan 1990).

Total binary and tertiary quench rates have been measured for the reaction Xe ($5p^5np$, np', n=6,7)+Cl_2 at thermal temperatures. Xenon atoms are excited by state-selective, two-photon absorption with an ultraviolet laser. The time-dependent fluorescence from the excited atom in the infrared, visible, and from XeCl* (B) product near 308 nm have been measured with subnanosecond time resolution. The decay rates are measured as a function of Cl_2 pressure to 20 Torr and Xe pressure to 400 Torr. The measured reaction rates ($k_2 \sim 10^{-9}$ cm^3 s^{-1}) are consistent with a harpoon model described in a separate paper. We also measure large termolecular reaction rates for collisions with xenon atoms ($k_3 \sim 10^{-28}$ cm^6 s^{-1}). Total product fluorescence has been examined using a gated optical multichannel analyzer. We measure unit branching fractions for high vibrational levels of XeCl* (B) with very little *C* state fluorescence observed.

24199 A multichannel harpoon model for reactive quenching of Xe $5p^5np$ by Cl_2. Bruce, M.R. (Physics Department, The University of Texas at Austin, Austin, Texas 78712 (US)); Layne, W.B.; Keto, J.W. *Journal of Chemical Physics (USA),* 92(1): 428-436 (1 Jan 1990).

A harpoon reaction model employing multiple crossings based on the formalism of Bauer *et al.* [J. Chem. Phys. **51**, 4173 (1969)] and Gislason and Sachs [J. Chem. Phys. **62**, 2678 (1975)] is developed to explain the large cross sections ($\sigma \sim 330$–975 Å^2) measured for the reaction Xe*($5p^5np$,np', n=6,7)+Cl_2. The model calculates the Landau–Zener transition probability for each intermediate ionic crossing with the covalent surface. The transition matrix elements are represented as a product of the electronic interaction (modeled by the empirical result of Olson *et al.* [Appl. Opt. **10**, (1971)]) and a Franck–Condon factor for the $Cl_2 \rightarrow Cl^-_2$ transition. The model predicts near unit probability for a transition to the ionic surface for impact parameters less than 20 Bohr. Once transfer occurs, the pair is captured by dissociation of Cl^-_2 to form XeCl*. The large temperature dependence observed qualitatively in the experiments is explained by the increased cross section for vibrationally excited Cl_2. A simple model for orbiting collisions is used to estimate the effect of termolecular collisions.

24200 Population pulsations and sidemode generation in semiconductors. Zhou, F.L. (Optical Sciences Center, University of Arizona, Tucson, Arizona 85721 (USA)); Sargent, M. III; Koch, S.W.; Chow, W.W. *Physical Review, A (General Physics) (USA),* 41(1): 463-474 (1 Jan 1990). DOE Contract AC04-76DP00789.

This paper applies many-body theory for an electron-hole plasma in semiconductors to multimode semiconductor-laser operation and sidemode generation. We derive third-order laser amplitude and frequency-determining equations and the corresponding propagation equations for multiwave mixing. The equations are similar to those found in multimode gas-laser theory. We include the effects of population pulsations in the total carrier density, but, due to the rapid carrier-carrier scattering, we explicitly suppress spectral hole burning. We also include band-gap renormalization and Coulomb enhancement contributions. The theory is evaluated numerically for the example of nondegenerate four-wave mixing in an amplifier configuration. We discuss the dependence of the sidemode intensity on the length of the active medium, the intermode beat frequency, and the pump-wave intensity.

24201 The photon accelerator: A novel method of frequency upshifting sub-picosecond laser pulses. Wilks, S.C. (Department of Physics, University of California, Los Angeles, CA 90024 (US)); Katsouleas, T.; Dawson, J.M. *AIP Conference Proceedings (American Institute of Physics) (USA),* 193(1): 448-470 (15 Oct 1989). (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

A novel method of frequency upshifting subpicosecond pulses of laser light, which makes use of relativistic plasma waves, is described in this paper. This method makes use of the fact that the response of a plasma to either a short laser pulse or a short relativistic electron beam is nearly identical. Thus, the wakefields, or electric fields, that are left behind in the plasma as either of these drivers pass are also very similar. Since electron acceleration in

plasma waves can effectively be thought of as the simple superposition of wakes, this analogy brings about the interesting question of whether the superposition of short laser pulse wakes would produce "acceleration" (or equivalently, frequency upshifting) of a trailing laser pulse. We estimate the rate of frequency upshift possible, and discuss some important physical limitations. Similarities and differences with another laser-plasma interaction, forward Raman scattering, are also discussed below. © 1989 American Institute of Physics

24202 Two-dimensional Vlasov treatment of free-electron laser sidebands. Sharp, W.M. (Lawrence Livermore National Laboratory, University of California, P.O. Box 808 L-626, Livermore, California 94550 (US)); Yu, S.S. *Physics of Fluids B (USA),* 2(3): 581-605 (Mar 1990). DOE Contract W-7405-ENG-48.

The Kroll–Morton–Rosenbluth equations [IEEE J. Quantum Electron. **QE-17**, 1436 (1981)] for a helical-wiggler free-electron laser are generalized to treat an electron beam with a prescribed radial density profile and an equilibrium distribution function that is an arbitrary function of the longitudinal action *J*. The principal approximation is the assumption that betatron frequencies of beam particles are low compared with typical synchrotron frequencies. Vlasov equilibria for finite-amplitude primary waves with time-varying phase are calculated for several distribution functions. Using these equilibria, radial eigenvalue equations for the frequency and growth rate of small-amplitude sidebands are derived and solved numerically. The radial mode structure is found to have no appreciable effect on sideband growth when the beam radius is large compared with $[2k_s \min(\Omega_0, d\phi_0/dz)]^{-1/2}$, where k_s and ϕ_0 are the wavenumber and phase of the primary wave and Ω_0 is the maximum synchrotron "frequency" in z of trapped electrons. In these effectively one-dimensional cases, the dispersion relation depends only on the distribution function and on a dimensionless density parameter $\bar{\eta}=k_w a^2{}_w \omega^2{}_b/(c^2\gamma^3{}_r\Omega^3{}_0 i)$, where k_w is the wiggler wavenumber, $a_w=eA_w/(mc^2)$ is the dimensionless wiggler vector potential, ω_b is the maximum plasma frequency of the beam, and γ_r is the Lorentz factor for resonant particles.

24203 Radiation-induced charge neutralization and interface-trap buildup in metal-oxide-semiconductor devices. Fleetwood, D.M. (Sandia National Laboratories, Albuquerque, New Mexico 87185-5800 (US)). *Journal of Applied Physics (USA),* 67(1): 580-583 (1 Jan 1990). DOE Contract AC04-76DP00789.

Effects of switched bias on the radiation response of metal-oxide-semiconductor (MOS) devices have been investigated. Transistors with 50-nm gate oxides were irradiated at +10-V bias to create a large trapped-hole density in the oxide. Irradiation was continued under varying negative and positive biases. Very little radiation-induced charge neutralization is observed at biases <-10 V for these devices. However, significant trapped-hole neutralization is observed at biases from −10 to 0 V, with a broad maximum in neutralization rate from −6 to −1 V. The peak charge neutralization rate is approximately equal to the rate of trapped-hole buildup under positive bias. This establishes an upper bound on the rate of radiation-induced charge neutralization, and demonstrates that, under peak neutralization conditions, the effective cross section for the capture of radiation-induced electrons by a filled hole trap is similar to the effective cross section for capture of a hole by an empty trap. Interface traps are found to build up at approximately the same rate when the oxide electric field at the Si/SiO_2 interface is positive, regardless of the field direction in the bulk of the oxide. This suggests that near-interfacial hydrogen may play a key role in interface-trap buildup in MOS devices.

24204 Field-effect transistor structure based on strain-induced polarization charges. Kuech, T.F. (IBM T. J. Watson Research Center, P.O. Box 218, Yorktown Heights, New York 10598 (USA)); Collins, R.T.; Smith, D.L.; Mailhiot, C. *Journal of Applied Physics (USA),* 67(5): 2650-2652 (1 Mar 1990).

We suggest a new field-effect transistor structure based on strain-induced polarization charges. The structure utilizes the pseudomorphic growth of a barrier layer on a substrate oriented in a polar direction (i.e., ⟨111⟩, ⟨211⟩, ...). Polarization charges in the large band-gap material are generated by the piezoelectric effect. A two-dimensional electron gas, whose density can be modulated by an external bias, forms at the heterointerface to screen the polarization charges. Zero-bias densities of several times 10^{11} e/cm^{-2} and turn-off threshold voltages of 0.5 V can be achieved in the (Ga,In)As-(Al,In)As model system. Both normally-on and normally-off structures are possible.

24205 Lasing threshold in quantum well surface-emitting lasers: Many-body effects and temperature dependence. Gourley, P.L. (Sandia National Laboratories, Albuquerque, New Mexico 87185 (USA)); Lyo, S.K.; Brennan, T.M.; Hammons, B.E.; Schaus, C.F.; Sun, S. *Applied Physics Letters (USA),* 55(26): 2698-2700 (25 Dec 1989). DOE Contract AC04-76DP00789.

The geometry of quantum well surface-emitting lasers has several important consequences. The ultrashort (~1 μm) vertical cavity defines longitudinal modes with energy separation greater than the bandwidth of spectral gain. The optical confinement of these modes can approach unity. To achieve lasing, high carrier densities (~10^{12} cm^{-2}) in the quantum well are required. The confined carriers interact through enhanced many-body exchange which influences both the lasing wavelength and threshold characteristics. Indeed, the exchange interaction can facilitate the lasing process. We theoretically and experimentally study the role of the short cavity and exchange interaction on the cw lasing threshold as a function of temperature. In constrast to edge emitters, the lasing threshold in these surface emitters exhibits a well-defined minimum at a particular temperature. The temperature of the minimum can be designed by merely changing the active layer thickness.

24206 Simple diffuser for production of laser speckle. Bonin, K.D. (Princeton University, Physics Department, Princeton, New Jersey 08544 (US)); Kadar-Kallen, M.A. *Applied Optics (USA),* 28(24): 5293-5297 (15 Dec 1989).

A passive optical element that is a simple, inexpensive, and effective way for producing laser speckle is described. The optical element, a random phase plate, was developed in our laboratory. The statistics of the speckle pattern it produces were measured and are discussed in this paper. The phase plate was used to produce a speckled beam using a 5-mW cw He–Ne laser with a Gaussian beam profile and using a pulsed Nd:YAG laser with a nonuniform intensity profile for which the mean intensity was 10^9 W/cm^2.

43 PARTICLE ACCELERATORS

Refer also to citation(s) 23562

24207 Proceedings of the 1989 IEEE [Institute of Electrical and Electronics Engineers] particle accelerator conference: Volume 1. Bennett, F. (Argonne National Lab., IL (USA)); Kopta, J. (eds.). 757p. Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). Sponsored by American Physical Society; U.S. Department of Defense; U.S. DOE Energy Research; National Science Foundation. From 1989 IEEE particle accelerator conference; Chicago, IL (USA); 20-23 Mar 1989.

This report contains papers on the following topics: low- and medium-energy accelerators and rings; accelerator-instrumentation, controls, and feedback; injectors and ion sources; high-energy accelerators and colliders; synchrotron radiation sources; beam dynamics; and applications. (LSP)

24208 Proceedings of the 1989 IEEE [Institute of Electrical and Electronics Engineers] particle accelerator conference: Volume 2. Bennett, F. (Argonne National Lab., IL (USA)); Kopta, J. (eds.). 733p. Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). Sponsored by American Physical Society; U.S. Department of Defense; U.S. DOE Energy Research; National Science Foundation. From 1989 IEEE particle accelerator conference; Chicago, IL (USA); 20-23 Mar 1989.

This report contains papers on the following topics: low- and medium-energy accelerators and rings; accelerator-instrumentation, controls, and feedback; injectors and ion sources; high-energy accelerators and colliders; synchrotron radiation sources; beam dynamics; free-electron lasers; pulsed power devices; rf, power supplies and operations; and applications. (LSP)

24209 Proceedings of the 1989 IEEE [Institute of Electrical and Electronics Engineers] particle accelerator conference: Volume 3. Bennett, F. (Argonne National Lab., IL (USA)); Kopta, J. (eds.). 678p. Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). Sponsored by American Physical Society; U.S. Department of Defense; U.S. DOE Energy Research; National Science Foundation. From 1989 IEEE particle accelerator conference; Chicago, IL (USA); 20-23 Mar 1989.

This report contains papers on the following topics: low- and medium-energy accelerators and rings; injectors and ion sources; high-energy accelerators and colliders; beam dynamics; pulsed power devices; superconducting components and magnets; and applications. (LSP)

4301 Design, Development, and Operation

Refer also to citation(s) 24001, 24259

24210 (BNL–43914) **The AGS [alternating gradient synchrotron]: Performance and potential.** Ratner, L.G. Brookhaven National Lab., Upton, NY (USA). [1989]. 26p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-890786–1: US particle accelerator school, Upton, NY (USA), 24 Jul - 4 aug 1989). Order Number DE90008814. Available from NTIS, PC A03/MF A01; OSTI; INIS.

This report discusses the following topics on the Brookhaven AGS: basic parameters, description of the accelerator complex and proton operation; operation with heavy ions and polarized protons; AGS upgrades and expanded potential. (LSP)

24211 Supercollider 1. McAshan, M. (ed.). 837p. Plenum Press, New York, NY (US) (1989). Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER40494. From International industrial symposium on the super collider; New Orleans, LA (USA); 8-10 Feb 1989.

This report contains papers on topics related to the Superconducting Super Collider. These topics are: Growing role of industry in accelerator technology; magnet technology; conventional facilities and technical systems; advanced particle detectors; superconducting wire and cable; cryogenics for large systems; and industrial opportunities on the SCC. The individual papers have been processed separately. (LSP)

24212 (FNAL/C–90/29-T) **Tevatron Collider physics.** Eichten, E.J. Fermi National Accelerator Lab., Batavia, IL (USA). Feb 1990. 20p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-890872–6: Workshop on physics at Fermilab in the 1990's, Breckenridge, CO (USA), 15-24 Aug 1989). Order Number DE90008811. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The physics of hadron colliders is briefly reviewed. Issues for further study are presented. Particular attention is given to the physics opportunities for a high luminosity ($\geq$ 100 pb^{-1}/experiment/run) Upgrade of the Tevatron Collider. 25 refs., 10 figs., 2 tabs.

24213 (FNAL-TM–1615) **Materials for ultra-high vacuum.** Lee, G. Fermi National Accelerator Lab., Batavia, IL (USA). 15 Aug 1989. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. Order Number DE90007908. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This report discusses materials for use in ultrahigh vacuum systems of 1×10^{-9} Torr or lower. The author briefly discusses alloys, solders, insulators and joining methods for vacuum systems. (JDL)

24214 (JINR–13-88-733) **Two-wave generator of subnanosecond radiation pulses on an yttrium-aluminium garnet.** Babikov, Yu.I.; Ir, K.S.; Mironov, V.E. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 4p. (In Russian). Order Number DE90621857. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Great attention is paid to the electron accelerator based on the mechanism of electron accelerator in the field of plasma wave, excited by laser radiation. The laser system master generator based on serial LTIPC-8 laser is described. The system is intended for investigating the plasma excitation processes initiated by two-frequency laser radiation beats. Pulse duration is $\leq$1 ns at 3-4 pulse train. Radiation on 1.0615 and 1.0641 μm wave length is generated. 5 refs.; 3 figs.

24215 (JINR-R–9-88-629) **Nanosecond pulse neutron generator based on collective laser plasma ion accelerator.** Gangrskij, Yu.P. (Joint Inst. for Nuclear Research, Dubna (USSR)); Kucher, A.M.; Zubkov, N.V.; Kirillov-Ugryumov, M.V.; Kozlovskij, K.I.; Prorvich, V.A. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 6p. (In Russian). Order Number DE90621855. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to Zh. Tekh. Fiz.

The mockup of a nanosecond neutron generator is designed. The regime of collective acceleration of ions of laser plasma produced by laser pulse with 30 mJ energy and 12 ns duration is realized in vacuum using the 200 keV electron beam with 5-7 kA beam current and 30 ns duration. Neutron yields per a pulse in $D(d,n)^3He$ and $T(d,n)^4He$ reactions are 10^7 and 10^8 neutron/pulse, respectively. Duration of neutron pulse is less than 30 ns. Registration of a great number (10^{13}) of accelerated deuterons with energy higher than 200 keV points to the possibility of high-effective collective ion acceleration at a comparatively small ($\approx$ 1 GW) power of electron beam. 3 refs.; 5 figs.

24216 (JINR-R–9-89-26) **On a possible conception of an acceleration complex for relativistic nucleus and electron beams.** Kovalenko, A.D. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1989. 6p. (In Russian). Order Number DE90621856. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The problems of combining in an accelerating complex of a superconducting synchrotron of 60-70 GeV/nucl. relativistic nuclei and a continuous action electron superconducting linear accelerator for the energy above 4 GeV and average beam current of 150-200 μA are considered. The possibility of using traveling-wave linac for the acceleration and bunching of heavy relativistic particles (protons nuclei) is pointed out. Such accelerating complex could provide one with opportunities for investigation of modern nuclear physics fundamental problems, for running experiments both on fixed target and nucleus-nucleus and electron-nucleus colliding beams, and for some applied purposes. 10 refs.; 1 tab.

24217 (LBL–28319) **Cyclotrons for the production of radioactive beams.** Clark, D.J. Lawrence Berkeley Lab., CA (USA). Jan 1990. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-891044–9: 1. international conference on radioactive nuclear beams, Berkeley, CA (USA), 16-18 Oct 1989). Order Number DE90009216. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper describes the characteristics and design choices for modern cyclotrons. Cyclotrons can be used in 3 areas in the radioactive beam field: the production of high energy heavy ion beams for use in fragmentation, the spallation of targets with high energy protons, and the acceleration of radioactive beams from low energy to the MeV/u range. 16 refs., 6 figs.

24218 (UCRL–102244) **Distributed computer control at the LLNL tandem.** Roberts, M.L.; Moore, T.L.; Hornady, R.S.; Davis, J.C. Lawrence Livermore National Lab., CA (USA). 1 Feb 1990. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900223–3: 2. international conference on nuclear microprobe technology and applications, Melbourne (Australia), 5-9 Feb 1990). Order Number DE90008912. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Livermore is developing hardware and software tools to provide automated operation of an FN tandem accelerator. Automated operation is planned for several nuclear analytical techniques including hydrogen depth profiling and accelerator mass spectrometry. The control system utilizes a distributed computer system to provide 16 bit precision in control of accelerator power supplies. 4 refs., 3 figs.

24219 Optical guiding and beat wave phase velocity control in the plasma beat wave accelerator. Esarey, E. (Plasma Theory Branch, Plasma Physics Division, Naval Research Laboratory, Washington, DC 20375-5000 (US)); Ting, A.; Sprangle, P. *AIP Conference Proceedings (American Institute of Physics) (USA)*, 193(1):

71-86 (15 Oct 1989). (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

Relativistic optical guiding allows two colinear short pulse radiation beams, provided they are of sufficiently high power, to propagate through a plasma without diffracting. By further accounting for finite radial beam geometry, it is possible for the phase velocity of the radiation beat (ponderomotive) wave to equal the speed of light. Provided the plasma wave phase velocity remains equal to the beat wave phase velocity, then phase detuning between the accelerated electrons and the plasma wave is no longer a limiting factor in determining the maximum energy gain in the plasma heat wave accelerator. As the plasma wave grows to sufficiently large amplitudes, however, it strongly affects the diffractive properties of the radiation beams. In particular, a large amplitude plasma wave will break up an initially uniform radiation beam into periodic beamlet segments, of length less than or equal to half a plasma wavelength, which remain optically guided as they propagate. In the plasma beat wave accelerator, for an optimal choice of the mismatch between the radiation beat frequency and the ambient plasma frequency, then the resonantly driven plasma wave may lead to enhanced focusing of the radiation beams. © 1989 American Institute of Physics

24220 High brightness laser development at LLNL and possible applications to the laser Wakefield problem. Darrow, C. (Lawrence Livermore National Laboratory, Livermore, CA 94550 (US)); Perry, M.D.; Patterson, F.; Campbell, E.M.; Katsouleas, T.; Mori, W.B. *AIP Conference Proceedings (American Institute of Physics) (USA),* 193(1): 50-56 (15 Oct 1989). (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

Development work of high brightness lasers at Lawrence Livermore National Laboratory based on both solid state and dye lasers is described.(AIP)

24221 Design of a grating for studying Smith-Purcell radiation and electron acceleration. Fernow, R.C. (Brookhaven National Laboratory, Upton, NY 11973 (US)). *AIP Conference Proceedings (American Institute of Physics) (USA),* 193(1): 87-103 (15 Oct 1989). DOE Contract AC02-76CH00016. (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

We describe work on the design fo a diffracton grating which we intend to use for studying the production of Smith-Purcell radiation and the acceleration of electrons. We have developed computer codes based on the solution of the appropriate Maxwell's equations. A specific grating profile is given which is feasible to construct and which supports enhanced surface accelerating modes. We examine the possibility of using the Smith-Purcell effect to make a beam position monitor. © 1989 American Institute of Physics

24222 Particle acceleration in a plasma filled IFEL. Guersey, Y. (National Synchrotron Light Source, Brookhaven National Laboratory, Upton, New York 11973 (US)). *AIP Conference Proceedings (American Institute of Physics) (USA),* 193(1): 134-140 (15 Oct 1989). DOE Contract AC02-76CH00016. (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

An earlier proposal by J. L. Bobin[1,2] to accelerate particles using a laser, undulator magnet, particle beam, and plasma is elaborated upon. The current status of research on the subject is presented, including problems and prospects. Estimates are given for parameters of an experiment at the Accelerator Test Facility at Brookhaven National Laboratory. © 1989 American Institute of Physics

24223 Cherenkov Wakefield accelerators: Rippled waveguides. Jones, M.E. (Los Alamos National Laboratory, Los Alamos, NM 87545 (US)); Keinigs, R.K.; Peter, W.; Wilks, S.C. *AIP Conference Proceedings (American Institute of Physics) (USA),* 193(1): 152-164 (15 Oct 1989). (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

The properties of using periodically rippled waveguides as wakefield accelerators are investigated. An analysis is performed in the ultrarelativistic limit which accurately predicts the amplitude, wavelength of the wakefield, and their dependences on waveguide and drive beam parameters. These devices are found to have the properties that the synchronous transverse wake vanishes, and the accelerating field is independent of the radial position in the drift tube and independent of the radial profile of the drive beam current. The effects of the nonsynchronous wakefields are discussed. Also, particle-in-cell simulations are performed which agree with the analysis and reveal self-consistent and collective effects in particle acceleration. © 1989 American Institute of Physics

24224 Laser Wakefield acceleration with high relativistic pumps. Katsouleas, T. (University of California at Los Angeles, Los Angeles, CA 90024 (US)); Mori, W.B.; Darrow, C.B. *AIP Conference Proceedings (American Institute of Physics) (USA),* 193(1): 165-171 (15 Oct 1989). (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

Preliminary scaling laws are found for the laser wakefield accelerator in the very non-linear regime where the normalized laser pump strengh $V_{osc}c=eE_0/m\omega_0 c>1$. Two important non-linear effects are an increase in the wake phase velocity (and hence the particle dephasing length) and an increase in the laser pulse length for optimal wake excitation. Application of the results to the proposed Livermore High-Brightness Lasers (HBL) is discussed here and in the accompanying paper by C. B. Darrow, *et al.* A preliminary 1-D PIC simulation is presented. © 1989 American Institute of Physics

24225 Elements of a realistic 17 GHz FEL/TBA design. Hopkins, D.B. (Accelerator & Fusion Research Division, Lawrence Berkeley Laboratory, University of California, 1 Cyclotron Road, Berkeley, CA 94720 (US)); Halbach, K.; Hoyer, E.H.; Sessler, A.M.; Sternbach, E.J. *AIP Conference Proceedings (American Institute of Physics) (USA),* 193(1): 141-151 (15 Oct 1989). DOE Contract AC03-76SF00098. (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

Recently, renewed interest in an FEL version of a two-beam accelerator (TBA) has prompted a study of practical system and structure designs for achieving the specified physics goals. This paper presents elements of a realistic design for an FEL/TBA suitable for a 1 TeV, 17 GHz linear collider. © 1989 American Institute of Physics

24226 The Mirrortron ion linear accelerator concept. Post, R.F. (Lawrence Livermore National Laboratory, P.O. Box 5511, L-644, Livermore, CA 94550 (US)). *AIP Conference Proceedings (American Institute of Physics) (USA),* 193(1): 298-310 (15 Oct 1989). DOE Contract W-7405-ENG-48. (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

A new type of ion linac, the Mirrortron, is described. It consists of a series of mirror cells within which high transient electric fields of space charge origin are generated, timed in synchronism with the arrival of a bunched ion beam. The space charge fields are generated by the sudden application of a localized pulsed mirror field within the cell. Accelerating fields up to two orders of magnitude higher than those in conventional ion linacs seem possible. The Mirrortron may be particularly suited for the acceleration of heavy-ion beams at high peak currents. Theoretical analyses and scaling laws are given. © 1989 American Institute of Physics

24227 Progress on inverse Cherenkov laser accelerator experiment. Kimura, W.D. (Spectra Technology, Inc., Bellevue, WA 98004-1495 (US)); Romea, R.D.; Tidwell, S.C.; Ford, D.H. *AIP Conference Proceedings (American Institute of Physics) (USA),* 193(1): 203-216 (15 Oct 1989). (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

Recent progress in understanding the experimental issues related to performing an inverse Cherenkov accelerator (ICA) experiment have been in two major areas. A comprehensive Monte Carlo computer model was developed that includes all pertinent effects, such as electron scattering and laser focusing of the electron beam. It also accurately models the laser beam focused through an axicon. The results of the model show that an appreciable amount of electron acceleration is possible using the anticipated conditions for the Brookhaven National Laboratory Accelerator Test Facility (ATF). It also predicts that for high γ *e*-beams (>1 GeV), the emittance growth of the *e*-beam caused by gas scattering is

not as severe as generally assumed. The second major accomplishment is the experimental proof-of-principle demonstration of various methods for producing a radially polarized annular laser beam that would be needed during the proposed ATF ICA experiment. © 1989 American Institute of Physics

24228 A 30 MW, 10 GHz gyroklystron with linear collider application. Lawson, W.; Latham, P.E.; Calame, J.; Skopec, M.; Welsh, D.; Hogan, B.; Naiman, M.; Read, M.E.; Striffler, C.D.; Reiser, M. *AIP Conference Proceedings (American Institute of Physics) (USA),* 193(1): 274-289 (15 Oct 1989). (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

In this paper, the final preparations for bringing the University of Maryland's 10 GHz, 30 MW gyroklystron experiment on-line are discussed. We describe the initial operation of the modulator and the acceptance tests performed on the electron gun. We explain the enhanced circuit modeling and present a two-cavity design which predicts an efficiency of 33% and a gain of 27 dB. The realization of the design is also discussed. In addition, we briefly discuss the output waveguide and the diagnostic for beam and RF characterization. Finally, a four-cavity circuit design is presented with its predicted operating parameters that can achieve the necessary gain and efficiency required for accelerator application. © 1989 American Institute of Physics

24229 The nonlinear CWFA. Schoessow, P. (Argonne National Laboratory, Argonne, IL 60439 (US)). *AIP Conference Proceedings (American Institute of Physics) (USA),* 193(1): 371-375 (15 Oct 1989). DOE Contract W-31-109-ENG-38. (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

The possible use of nonlinear media to enhance the performance of the Cherenkov Wakefield Accelerator (CWFA) is considered. Numerical experiments have been performed using a new wakefield code which demonstrate larger gradients and transformer ratios in the nonlinear CWFA than are obtained in the linear case. © 1989 American Institute of Physics

24230 Simulation of short intense laser pulse propagation in the laser wakefield accelerator. Ting, A. (Naval Research Laboratory, Washington, D.C. 20375 (US)); Sprangle, P.; Esarey, E. *AIP Conference Proceedings (American Institute of Physics) (USA),* 193(1): 398-407 (15 Oct 1989). (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

In the Laser Wakefield Accelerator (LWFA), an intense picosecond laser pulse propagates through a plasma and nonresonantly generates large amplitude axial and transverse wakefields. The intense axial electric field associated with these wake plasma waves could be used for accelerating electron beams to very high energies. The propagation of such short laser pulses through a plasma and the generation of the wakefields are studied with numerical simulations. The formulation is a three-dimensional cold fluid model with self-consistent density perturbation and relativistic focusing effects. The laser pulse shape is found to be modified which in turn affects the wakefields. © 1989 American Institute of Physics

24231 Argonne plasma wake-field acceleration experiments. Rosenzweig, J.B. (High Energy Physics Division, Argonne National Laboratory, Argonne, IL 60439 (US)); Cole, B.; Gai, W.; Konecny, R.; Norem, J.; Schoessow, P.; Simpson, J. *AIP Conference Proceedings (American Institute of Physics) (USA),* 193(1): 340-370 (15 Oct 1989). DOE Contract W-31-109-ENG-38. (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

The recent experimental advances in the plasma wake-field Accelerator research at Argonne National Laboratory are reviewed.(AIP)

24232 Laser wakefield acceleration and relativistic optical guiding. Sprangle, P. (Plasma Theory Branch, Plasma Physics Division, Naval Research Laboratory, Washington, DC 20375-5000 (US)); Esarey, E.; Ting, A.; Joyce, G. *AIP Conference Proceedings (American Institute of Physics) (USA),* 193(1): 376-387 (15 Oct 1989). (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

An electron acceleration method is investigated which employs a short ($\tau_L \sim 2\pi\omega^{-1}{}_p \sim 1$ picosec), high power ($P \geq 10^{15}$ W), single frequency laser pulse to generate large amplitude ($E \geq 1$ GeV/m) plasma waves (wakefields). A correctly placed trailing electron bunch can be accelerated by the longitudinal electric field and focused by the transverse electric field of the wake plasma waves. The acceleration distance of this laser wakefield is most severely limited by the diffraction length of the laser pulse. However, at sufficiently high laser powers [$P \geq 17(\omega/\omega_p)^2$GW], relativistic optical guiding may be used to prevent the pulse from diffracting within the plasma. © 1989 American Institute of Physics

4302 Beam Dynamics, Field Calculations, and Ion Optics

Refer also to citation(s) 24230, 24232, 24303, 24308, 25121, 25128, 25233

24233 (ABC–1) **Round beams v flat beams integrated luminosity considerations.** Donald, M. Stanford Linear Accelerator Center, Menlo Park, CA (USA). 8 Jan 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515;AC03-76SF00098. Order Number DE90008652. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We show that, although a factor of 2 increase in maximum luminosity may be gained by using round beams rather than flat beams, the gain in integrated luminosity may be less than 2. 1 tab.

24234 (ABC–2) **The advantages of flat beams in head-on collisions.** Hutton, A. Stanford Linear Accelerator Center, Menlo Park, CA (USA). 10 Feb 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515;AC03-76SF00098. Order Number DE90008653. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This note extends some considerations of β_y^* (the value of the vertical beta function at the Interaction Point) in coupled and uncoupled machine due to E. Keil.

24235 (ANL/PPRNT–90-205) **Modulation of continuous electron beams in plasma wake-fields.** Rosenzweig, J.B. Argonne National Lab., IL (USA). 8 Sep 1988. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90008708. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In this paper we discuss the interaction of a continuous electron beam with wake-field generated plasma waves. Using a one-dimensional two fluid model, a fully nonlinear analytical description of the interaction is obtained. The phenomena of continuous beam modulation and wave period shortening are discussed. The relationship between these effects and the two-stream instability is also examined. 12 refs., 1 fig.

24236 (BNL–44311) **Transverse mode coupling in RHIC.** Raka, E. Brookhaven National Lab., Upton, NY (USA). 21 Feb 1990. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (AGS/AD–90-2). Order Number DE90008849. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In the Proceedings of the Workshop on the RHIC Performance, it was stated that the transverse mode coupling instability, posed a potential intensity limitation for protons. This was based on the expression $I_b = 4(E_t/qe)\ Q_s\ 4\ \sqrt{\pi}\ \sigma\ U/(\mathrm{Im}\ (Z_\perp) < \beta_\perp > R\ 3)$ where E_t is the total energy, q the charge state, Q_s the synchrotron tune, $< \beta_\perp >$ the average beta function, R the machine radius, and σ_ℓ the rms bunch length of a Gaussian distribution in longitudinal phase space. For a $< \beta_\perp >$ of 55 m and 10^{11} protons/bunch, the allowed impedance $Z_\perp$ for protons at injection, where $Q_s = 0.11 \times 10^{-3}$, would be less than 1.2 MΩ/m. The purpose of this report is to discuss the consequences of two factors that were omitted in this equation, which comes from the ZAP program, to RHIC. These are the space charge impedance and the incoherent tune spread of the beam.

24237 (FNAL/C–90/40) **Nonlinear plasma and beam physics in plasma wake-fields.** Rosenzweig, J.B. Fermi National Accelerator Lab., Batavia, IL (USA). 12 Feb 1990. 36p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-900264–3: Topical conference on research trends in nonlinear and relativistic effects in plasmas, San Diego, CA (USA), 5-8 Feb 1990). Order Number DE90008812. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In experimental studies of the Plasma Wake-field Accelerator performed to date at the Argonne Advanced Accelerator Test Facility, significant nonlinearities in both plasma and beam behavior have been observed. The plasma waves driven in the wake of the intense driving beam in these experiments exhibit three-dimensional nonlinear behavior which has as yet no quantitative theoretical explanation. This nonlinearity is due in part to the self-pinching of the driving beam in the plasma, as the denser self-focused beam can excite larger amplitude plasma waves. The self-pinching is a process with interesting nonlinear aspects: the initial evolution of the beam envelope and the subsequent approach to Bennett equilibrium through phase mixing. 35 refs., 10 figs.

24238 (FNAL-TM–1646) **Intrabeam scattering in the Tevatron collider upgrade.** Finley, D. Fermi National Accelerator Lab., Batavia, IL (USA). 4 Dec 1989. 73p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. Order Number DE90007907. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

This report explores the effects of intrabeam scattering on the integrated luminosity for some conditions under consideration for the early stages of the Tevatron collider upgrade. This report concludes that intrabeam scattering effects, although they are hoped to become clearly visible, are not expected to wash out gains made by lowering β^* and emittances. It is not the intent of this report to provide a physics tutorial on intrabeam scattering. However, a bibliography is provided at the end of this report which may be of use in that regard. 14 figs.

24239 (JINR-R–11-88-606) **Averaged equations for nonlinear resonance 3 ν_x=2 in high-order approximations by Krylov-Bogolyubov method.** Amirkhanov, I.V.; Zhidkov, E.P.; Zhidkova, I.E. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation. 1988. 7p. (In Russian). Order Number DE90621860. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The third-order resonance ($3\nu_x$=2) used for primary beam extraction from the JINR synchrophasotron is investigated. The reduced equations are obatiend by the Krylov-Bogolyubov method in the third approximation. These equations are studied. 11 refs.; 2 figs.

24240 (JINR-R–11-88-683) **The magnetic field calculation method for the systems with rotational symmetry of ferromagnetic.** Akishin, P.G. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 12p. (In Russian). Order Number DE90622140. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Integral equation method was used for calculation of the field in magnetic systems having rotational symmetry of the ferromagnet. The properties of symmetry of matrices of discretized equations are investigated. The iterational method for solving arising linear and nonlinear equation systems is proposed. Some numerical results are presentes. 7 refs.; 9 figs.; 2 tabs.

24241 (JINR-R–11-88-714) **Effect of $2\nu_z+2\nu_x$=3, $3\nu_z-\nu_x$=2, $4\nu_z+\nu_x$=4 resonances on betatron oscillation amplitudes.** Amirkhanov, I.V.; Zhidkov, E.P.; Zhidkova, I.E. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 14p. (In Russian). Order Number DE90621861. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The effect of nonlinear resonances on betatron oscillation amplitudes in a cyclic accelerator are investigated. The study is performed by the Krylov-Bogolyubov averaging method in high approximation. The REDUCE - 3.2 analytical programs system is applied. The sufficient conditions for betatron oscillation amplitudes finiteness under effect of these resonances are obtained in the third approximation of the JINR synchrophasotron. 10 refs.

24242 (KFTI–88-2) **Serphotron acceleration of charged particles in periodical structures.** Buts, V.A.; Ognivenko, V.V. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 5p. (In Russian). Order Number DE90621864. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Possibility of serphotron mechanism of charged particle acceleration by the field of electromagnetic waves, propagating in periodical electrodynamic structures was shown. Acceleration rate was determined and transverse and phase stability of charged particle motion was considered. 4 refs.

24243 (KFTI–88-11) **Dynamical stability of dense ion bunch in a linear accelerator.** Korostelev, A.N.; Repalov, N.S.; Khizhnyak, N.A. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 16p. (In Russian). Order Number DE90621862. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Dynamics of ellipsoidal bunches of charged particles in accelerating electromagnetic field was studied on the basis of variational principle. Lagrangian function of the bunch was calculated with account of its deformation in the wave field and under the effect of forces of space self-charge. Self-consistent system of equations for the field and its particles was obtained and investigated. Criteria of stability of accelerator operation upon the whole were established. Some problems of ion bunch stability in focusing channels were studied as well. 7 refs.; 8 figs.

24244 (KFTI–88-12) **Time-dependent beam structure at the realization of automodulation acceleration regime in the feedback electron linear accelerator.** Ajzatskij, N.I. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 8p. (In Russian). Order Number DE90621863. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Theoretical consideration is given to time dependence of beam structure on external parameters in the feedback electron linear accelerator at the realization of automodulation acceleration regimes. It is shown that regulation of current pulse duration with preservation of the period of their following is possible for such regimes. 9 refs.; 3 figs.; 1 tab.

24245 (LBL–28222) **Stability of high-brilliance synchrotron radiation sources.** Chattopadhyay, S. Lawrence Berkeley Lab., CA (USA). Dec 1989. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-890802–25: 7. synchrotron radiation instrumentation (SRI) national conference, Berkeley, CA (USA), 6-10 Aug 1989). Order Number DE90009049. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the following topics: characteristics of synchrotron radiation sources; stability of the orbits; orbit control; nonlinear dynamic stability; and coherent stability and control. 1 ref., 5 figs., 1 tab. (LSP)

24246 The attainment of large accelerating gradients using near field synchrotron radiation. Decker, G. (National Synchrotron Light Source, Brookhaven National Laboratory, Upton, NY 11973 (US)). *AIP Conference Proceedings (American Institute of Physics) (USA),* 193(1): 61-70 (15 Oct 1989). DOE Contract AC02-76CH00016. (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

Lienard-Wiechert potentials are used to find the electromagnetic field everywhere in free space resulting from a point charge moving on a helical trajectory. The total power emitted as synchrotron radiation from a particle on a circular path is calculated. The point charge results are generalized to the case of a line charge, and formulae are presented which can easily be evaluated numerically. A useful gradient of 80 MeV/m per kA of peak driving beam current over a distance of 1 cm is calculated using two 5 MeV driving beams moving on 1 cm radius helical orbits with bunch length 1 mm. © 1989 American Institute of Physics

24247 Self-field-induced chaoticity in the electron orbits in a helical-wiggler free-electron laser with axial guide field. Chen, C. (Plasma Fusion Center, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (US)); Davidson, R.C. *Physics of Fluids B (USA),* 2(1): 171-178 (Jan 1990).

The motion of a relativistic electron is analyzed in the field configuration consisting of a constant-amplitude helical wiggler magnetic field, a uniform axial magnetic field, and the equilibrium self-electric and self-magnetic fields produced by the non-neutral electron beam. By generating Poincare surface-of-section maps, it is shown that the equilibrium self-fields destroy the integrability of the motion, and consequently part of phase space becomes chaotic. In particular, the Group I and Group II orbits can be fully chaotic if the self-fields are sufficiently strong. The threshold value of the self-field parameter $\epsilon=\omega^2_{pb}/4\Omega^2_c$ for the onset of beam chaoticity is determined numerically for parameter regimes corresponding to moderately high beam current (and density). It is found that the characteristic time scale for self-field-induced changes in the electron orbit is of the order of the time required for the beam to transit one wiggler period. An analysis of the first-order, self-field-induced resonances is carried out, and the resonance conditions and scaling relations for the resonance width are derived. The analytical estimates are in good qualitative agreement with the numerical simulations.

24248 **Calculation of longitudinal and transverse wake-field effects in dielectric structures.** Gai, W. (Argonne National Lab, Argonne, IL 60439 (US)). *AIP Conference Proceedings (American Institute of Physics) (USA),* 193(1): 111-120 (15 Oct 1989). DOE Contract W-31-109-ENG-38. (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

Results of calculations of the wake field effects produced in a dielectric structure by a charged particle are presented. The results indicate that dielectric wake field acceleration method can produce a very high acceleration gradient which is required for the next generation linear colliders. One example discussed gives 100 Mev/m for a maximum accelerating gradient.(AIP)

24249 **Application of intense relativistic electron beams in RF generation–relativistic Klystron amplifier.** Friedman, M. (Naval Research Laboratory, Washington, DC 20375-5000 (US)); Serlin, V.; Lau, Y.Y.; Krall, J. *AIP Conference Proceedings (American Institute of Physics) (USA),* 193(1): 104-110 (15 Oct 1989). (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

This research addresses the development of new high power RF Klystron-like amplifiers. These amplifiers use modulated intense relativistic electron beams of power exceeding 10 gigawatts. The development of the new amplifier resulted from successful experiments in 1986, demonstrating generation of a completely modulated intense relativistic electron beam, of power 1–10 gigawatts by a lower power (≥100 kw) external RF source. One of the important results in the experiment was that the phases of the electron bunches were "locked" to the RF source and phase variations were below 4 degrees. These electron bunches traversing special structures radiated RF power at a 3 gigawatts level. With the knowledge accumulated during the last three years we can project RF sources, using modulated IREBs, capable of generating gigawatts of RF power with energy per pulse in the 100 kilojoule range. This kind of power makes such devices interesting for heating plasmas to thermonuclear temperatures and for powering large RF accelerators. © 1989 American Institute of Physics

24250 **Multi-stage wake-field accelerator.** Gai, W. (Argonne National Laboratory, Argonne, IL 60439 (US)). *AIP Conference Proceedings (American Institute of Physics) (USA),* 193(1): 121-125 (15 Oct 1989). DOE Contract W-31-109-ENG-38. (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

A multi-stage wake field acceleration scheme to overcome the low transformer ratio problem and still provide high accelerating gradients is proposed. An example of parameter set based on this scheme for a 500 Gev collider is given.(AIP)

24251 **Summary of the discussions of the working group on wake fields in media and structures.** Norem, J. (Argonne National Laboratory, Argonne, Il. 60439 (US)). *AIP Conference Proceedings (American Institute of Physics) (USA),* 193(1): 295-297 (15 Oct 1989). (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

Summary of the discussions of the working group on wake fields in media and structures which met during the workshop on Advanced Accelerator Concepts is given.(AIP) © 1989 American Institute of Physics

24252 **A general theory of beam breakup instabilities in linear accelerators.** Lau, Y.Y. (Plasma Theory Branch, Plasma Physics Division, Naval Research Laboratory, Washington, DC 20375-5000 (US)); Colombant, D.G. *AIP Conference Proceedings (American Institute of Physics) (USA),* 193(1): 244-273 (15 Oct 1989). (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

We re-examine the beam breakup instabilities (BBU) in linear accelerator with the use of a simple continuum model. The standard mode coupling approach in microwave engineering is adopted to treat the cumulative, regenerative and convective BBU in a unified manner. In addition to being able to recover all major classical solutions as limiting cases, our simplifed treatment, in several instances, provides a rather different perspective on the role of the focusing magnetic fields, spreads in betatron frequencies and spreads in the breakup mode frequencies, etc. Dimensionless parameters are constructed which provide an immediate assessment of the relative importance of these effects, as well as the anticipated BBU growth when these various factors are incorporated. We have also devised a highly accurate numerical scheme which directly integrates the governing equations. Excellent agreement between the numerical results and the analytic theory is observed. We have incorporated in our numerical study other effects such as stagger tuning and nonlinear focusing which defy analytical treatment. © 1989 American Institute of Physics

24253 **Localized profiles of optical beams in plasma.** Kurki-Suonio, T. (Department of Physics and Institute of Fusion Studies, University of Texas at Austin, Austin, Texas 78712 (US)); Morrison, P.J.; Tajima, T. *AIP Conference Proceedings (American Institute of Physics) (USA),* 193(1): 227-243 (15 Oct 1989). (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

Self-focusing of an intense optical beam in a plasma is studied, including the nonlinear effects of both the relativistic electron mass and the ponderomotive potential due to the electromagnetic wave. An exact steady asymptotic solution of beam propagation in a localized solitary wave form is obtained in slab geometry. Amplitude-width scaling relations are obtained, which imply that the width is limited to be less than square root of three of the collisionless skin depth. In the nonrelativistic limit, keeping only the relativistic mass effects, our solution reduces to the solution obtained by Schmidt and Horton. The asymptotic nature of the solitary wave is tested using a recently developed numerical particle simulation code. © 1989 American Institute of Physics

24254 **On the re-acceleration of bunched beams.** Whittum, D.H. (Lawrence Berkeley Laboratory, University of California, Berkeley, CA 94720 (US)); Sessler, A.M.; Craig, G.D.; DeFord, J.F.; Yu, D.U.L. *AIP Conference Proceedings (American Institute of Physics) (USA),* 193(1): 433-447 (15 Oct 1989). DOE Contract AC03-76SF00098;W-7405-ENG-48;AC03-87ER80529. (CONF-890197–: Workshop on advanced accelerator concepts, Lake Arrowhead, CA (USA), 9-13 Jan 1989).

We examine the re-acceleration of a bunched beam through a linear induction accelerator (LIA) cavity, with attention to the energy lost through coupling to the TM modes of the structure. We find that the energy lost at 1 kA peak current is a small fraction of the boost which the LIA is designed to impart. We discuss implications for a Relativistic Klystron or Free Electron Laser (FEL) version of the Two-Beam Accelerator (TBA). © 189 American Institute of Physics

24255 **Controlling transverse multibunch instabilities in linacs of high-energy linear colliders.** Thompson, K.A. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94309 (US)); Ruth, R.D. *Physical Review, D (Particles Fields) (USA),* 41(3): 964-977 (1 Feb 1990). DOE Contract AC03-76SF00515.

In this paper, we study multibunch beam breakup, with emphasis on theoretical methods applicable to the design of a linear collider with a center-of-mass energy near 1 TeV. One way to significantly

improve the luminosity and energy transfer efficiency of such a collider is to accelerate a train of bunches rather than just a single bunch each time the linac accelerating structure is filled with a pulse of rf energy. For the required bunch charges and intensities, the transverse instability due to the wake fields produced in the accelerating structure is very severe unless measures are taken to control it. Therefore, we examine the effects of several methods of reducing this instability: (1) use of damped acceleration cavities, (2) placing the bunches near nodes of the transverse wake fields produced by preceding bunches, (3) introducing a spread (over different cells of the accelerating structure) of the individual mode frequencies in the transverse wake field, and (4) varying the strength of the transverse focusing from bunch to bunch, in such a way as to partially cancel the effects of the wake fields from preceding bunches. We present examples illustrating the effectiveness of these cures, using realistic linear-collider design parameters.

4303 Auxiliaries and Components

Refer also to citation(s) 24308, 24843

24256 (BNL–43886) **Un: PES experiment control program: User's manual.** Garrett, R.F.; Lepeyre, J.; Hulbert, S.L. Brookhaven National Lab., Upton, NY (USA). National Synchrotron Light Source Dept. Jan 1990. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. Order Number DE90008822. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This document is a user's manual for the data acquisition program Un. Un controls data acquisition equipment and organizes and plots data for spectroscopy experiments and is installed at a number of beamlines at the VUV ring at the NSLS. This document deals specifically with the installation at beamline U14A, although most aspects will also apply to other beamline versions. Then when invoking the program the 'n' is usually replaced by the beamline number, e.g., u14, u5. Un is written in the C programming language under the VENIX operating system, an implementation of UNIX which runs on the IBM PC. Control of the monochromator and electron analyzer, as well as simple data manipulation, is provided through an interactive 'language' of two letter commands. You should be able to use Un immediately by skipping to the section 'Starting the Program.' If, however, you encounter problems in getting the program to run, the following section, 'Un and UNIX' will be helpful. In any case, it is advisable to read this section eventually if you are not familiar with the UNIX operating system.

24257 (DOE/ER/40350–3) **Multiple coil pulsed magnetic resonance method to measure the SSC bending magnet multipole moments: Technical progress report.** Clark, W.G. California Univ., Los Angeles, CA (USA). Dept. of Physics. 9 Mar 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-87ER40350. Order Number DE90008869. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This document describes the technical progress made during the current contract period (4-1-89 to 3-31-90) of US DOE Contract AC02-87ER40350. The main emphasis of the current contract year has been to continue development of the high frequency (to 300 MHz) instrumentation, to test the system on a prototype bending magnet, to construct the high frequency 32-channel electronics and probes, and to do computer simulations for optimizing design parameters. Experience gained from tests made on a dipole magnet at Lawrence Berkeley Laboratory was extremely valuable and has resulted in substantial modifications to the original designs. These, and other items are discussed in this paper.

24258 (FNAL-TM–1621) **Tests of high gradient superconducting quadrupole magnets for the Tevatron.** Lamm, M.J.; Carson, J.; Gourlay, S.; Hanft, R.; Koepke, K.; Mantsch, P.; McInturff, A.D.; Riddiford, A.; Strait, J. Fermi National Accelerator Lab., Batavia, IL (USA). Sep 1989. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-890701–27: International cryogenic materials conference, Los Angeles, CA (USA), 24-28 Jul 1989). Order Number DE90007909. Available from NTIS, PC A02/MF A01; OSTI; INIS.

Tests have been completed on three prototype magnets and two production magnets to be used for the Tevatron Dϕ/Bϕ low- β insertion. These cold iron, two shell quadrupoles are made of 36 strand Rutherford type NbTi superconducting cable. Magnet field gradients well in excess of the design 1.41 T/cm have been achieved at a transfer function of 0.291 T/cm/kA. Quench performance at 4.2 K and 3.7 K and magnetic multipole measurement data are presented and discussed. 9 refs., 4 figs., 4 tabs.

24259 (FNAL-TM–1641) **The design of a large aperture high field dipole.** Harfoush, F.; Harrison, M.; Kerby, J.; Koepke, K.; Mantsch, P.; Nicol, T.; Riddiford, A.; Theilacker, J. Fermi National Accelerator Lab., Batavia, IL (USA). Dec 1989. 149p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. Order Number DE90007910. Available from NTIS, PC A08/MF A01; OSTI; INIS.

The impetus for this design report originated in the Snowmass 88 meeting where the subject of higher energies within the constraints of the existing Tevatron tunnel enclosure was investigated. It was determined that beam transport to the fixed target experimental areas was possible up to an energy of ~1.5 Tev. Collider operation was feasible at somewhat higher energies (1.8 Tev), primarily limited by the ability to design a single turn beam abort system within the constraints of the straight section length. A new accelerator in the existing tunnel would, of necessity, have a similar though not identical lattice and straight section layout to the present Tevatron. Thus when issues arose in the magnet design requiring input from the accelerator standpoint we have assumed a Tevatron like machine. The possibility of using these high field magnets as elements in the existing Tevatron to create new 'warm space,' for another Interaction Region for example, also emphasizes compatibility with the present machine. 16 refs., 62 figs., 23 tabs.

24260 (JINR–9-88-846) **High voltage generator of sawtooth voltage for smearing the cyclotron ion beam.** Talakh, M. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions. 1988. 6p. (In Russian). Order Number DE90621884. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

For uniform smearing out of heavy ion beam in a cyclotron over band width during irradiation of polymer films in manufacturing nuclear filters the electrostatic method of beam deflection is used. The deflecting plates should be fed by a high (up to 30 kV from peak to peak) sawtooth voltage with 6-12 kHz frequency. A simple generator of such a voltage is presented. 3 refs.; 5 figs.

24261 (JINR–13-88-586) **The study of the effect of surface aluminizing on hydrogen penetration through target wall at high pressures and temperatures.** Bystritskij, V.M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems); Voshedchenko, B.M.; Granovskij, V.B. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 6p. (In Russian). Order Number DE90621882. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Aluminizing of the wall surface of a vessel made of the alloy E1 698 allowed a 30-fold reduction of the hydrogen penetration through the target wall at the 1023 K temperature and 98 MPa pressure. 2 refs.; 3 figs.

24262 (JINR–13-88-827) **Digital volstron device for ion source telecontrol system.** Romanov, Yu.I. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1988. 10p. (In Russian). Order Number DE90621872. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A digital volstron carried as a compact undetachable device is described. The device consists of a 10 metre piece of a fibre-optical cable, an emitter, a photoreceiver and the microelectron circuits. Such integrated fibre-optical line of communication has the best energy parameters and more high reliability as compared with the detachable constructions similar to it. 16 refs.; 7 figs.

24263 (JINR–16-88-613) **Characteristics of radiation fields behind shields of light relativistic nucleus beams transport channel.** Bamblevskij, V.P.; Krylov, A.R.; Timoshenko, G.N. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 11p. (In Russian). Order Number DE90621883. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to At. Ehnerg.

The shielding physics experiments performed at α-particles and ^{12}C beams with 3.65 GeV/nucleon energy are described. The characteristics of the radiation field behind side concrete shielding 3 and 1 meter thick, irradiating by secondary radiation from thick tagets, bombarded by α-particles, ^{12}C nuclei and field behind 2 meter concrete trap, bombarded by ^{12}C nuclei are investigated. The obtained results and shielding experiments proton beams are compared. 19 refs.; 7 figs.; 1 tab.

24264 (JINR-R–9-88-637) **Theoretical consideration of a possibility of acceleration and extraction of H^- ions in the JINR phasotron.** Kol'ga, V.V.; Thanh, L.K.; Onishchenko, L.M. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 13p. (In Russian). Order Number DE90621873. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Analytical and numerical calculations have been carried out to find losses of H^- ions at their acceleration in the JINR phasotron. The energy of H^- ions is limited by beam losses due to electric dissociation in the magnetic field and is 130-150 MeV. A basic possibility of simultaneous acceleration and extraction of two beams (protons and H^- ions) in the JINR phasotron is considered. 15 refs.; 7 figs.

24265 (JINR-R–9-88-707) **Studying beam extraction from the DTs-1 cyclotron with account for space charge effects.** Vorozhtsov, S.B.; Dmitrievskij, V.P.; Kalinkina, M.B.; Saenko, V.A. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 12p. (In Russian). Order Number DE90621874. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The methods for high-current beam extraction from a vacuum chamber of the DTs-1 cyclotron with account for space charge effects are considered. Limiting value of accelerated particle beam intensity due to longitudinal space charge effect is about 1-1.5mA under condition of single-turne beam extraction with 100% efficiency. Development of a principally new method of particle extraction is required for further increase of beam intensity. 15 refs.; 6 figs.; 2 tabs.

24266 (JINR-R–9-88-872) **Results of adjustment of electron source for the LIU-30 accelerator.** Androsov, A.V.; Kladnitskij, V.S.; Platonov, S.L.; Shvets, V.A. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics. 1988. 4p. (In Russian). Order Number DE90621870. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A new design of an electron source (electron gun) for the LIU-30 accelerator is described. Unlike the earlier used ones it has been made as a separate unit connected via a special adapter with increasing pulsed 300 kW transformer constructed on the base of an accelerating section. Ferromagnetic screen of a special shape and antisolenoid placed behind the cathode in a hollow of an oil-filled insulator and switched on antiparallely to the main focusing solenoid permit to diminish the gun emittance by 10-15%due to zero magnetic field in the cathode region. Various electron-optical systems were tested and that one based on the Pierse gun in which the anode orifice was covered with a wire gauze with 2.5 mm cell was chosen. 3 refs.; 1 fig.

24267 (JINR-R–9-88-895) **Study of the ion source prototype with SHF heating of electrons at 2.45 GHz frequency.** Efremov, A.A.; Kutner, V.B. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions. 1988. 4p. (In Russian). Order Number DE90621871. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The investigation of a possibility to produce light ions in the mass range up to oxygen for A/Z=2-5 at a comparatively low plasma density ($n=7x10^{10}$ cm^{-3}) is performed. The test setup is made on the base of a single-mode cavity resonator. The axial mirror magnetic field is generated with solenoid coils. There is no hexapole. The charge distribution is given and the possibility of the production of N^{3+} ions is shown. Absorption of the high frequency power occurs in the upper hybrid resonance region. The resonance state is unstable. 5 refs.; 3 figs.

24268 (JINR-R–11-88-335) **Solution of a magnetostatic nonlinear inverse problem by the regularization method.** Zhidkov, E.P.; Kuts, I.V.; Polyakova, R.V.; Shelaev, I.A.; Yudin, I.P. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 10p. (In Russian). Order Number DE90621876. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to the Organaizing committee of the 10. Soviet-Czechoslovakian meeting Application of functional methods and of the methods of theory of functions to mathematical physics problems (CSSR, September 1988) and to Zh. Vychisl. Mat. Mat. Fiz.

A magnetostatic nonlinear inverse problem is investigated for a case when it is needed to create a required magnetic field using conductors which coordinates vary on condition that current value is equal in all the conductors. It is known that the same problems fall under the category of noncorrect problems. Mathematical statement of tis type of problems is given. The proposed numerical algorithm using the regularization method by A.N. Tikhonov permits to overcame comparatively easily the difficuties connected with badly conditioned equation systems to which usually the magnetostatic inverse problems reduce. This algorithn allows one to calculate the existing winding geometry of superconducting dipole ironless magnet which ensures a magnetic field homogeneity up to 10^{-5} within a rectangular aperture. 5 refs.; 5 figs.; 3 tabs.

24269 (JINR-R–11-88-608) **Automated system for parameter control of Polarized deuteron cryogenic source.** Zhigulin, I.V.; Shutov, V.B. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 6p. (In Russian). Order Number DE90621879. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A system for parameter control of Polaris polarized deutron cryogenic source is described. Advantage of the system is its noiseproofness when operating under strong electrical noises. The system consists of two main parts: positioned on a high-voltage column supply station of foreinjector and a subsystem on the control desk of LU-20 linear accelerator. Each sub system is controlled by an autonomous microcomputer. The systems are connected via fast sequential asynchronous data transfer channel. High voltage (700 kV) connection channel decoupling is carried out by means of optolines. 4 refs.; 1 fig.

24270 (JINR-R–13-88-554) **Target for operation with hydrogen heavy isotopes of pressures up to 1000 at and temperatures up to 1050 K.** Arkhipov, A.P. (AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Geokhimii i Fiziki Mineralov); Granovskij, V.B.; Bystritskij, V.M. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 6p. (In Russian). Order Number DE90621880. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A target designed for the study of the muon-catalized fusion in the mixture (D_2+T_2) at pressures up to 1000 at and at temperatures up to 1050 K is described. The multilayer protective coating of the heat-resisting alloy E1 698 allowed the deuterium flux through the target wall to be reduced by a factor of more 10^2 at T=1050 K and P=1000at. 6 refs.; 4 figs.

24271 (JINR-R–13-88-751) **Beam current integrator.** Bienkowski, A. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 4p. (In Russian). Order Number DE90621877. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A beam current integrator covering the range from $5x10^{-10}$ up to $3x10^{-5}$ A is described. The principle of operation is based on using the amplifier with a pulse feedback loop and the input charging capacitor. The accuracy and longtherm stability is better than 1%. The operating principle of the integrator provides an accurate measuring of charge independently on current character (fluctuations, nonuniformity). The circuit is presented in which the ordinary components are used. 2 refs.; 2 figs.

24272 (JINR-R–13-88-776) **Investigation of a possibility of using the acoustic emission method to test the quality of items made of hydride-producing materials in the course of their reversible interaction with hydrogen.** Artyukhov, V.I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii); Borisova, A.A.; Bystritskij, V.M. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 6p. (In Russian). Order Number

DE90621881. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The acoustic emission parameters are shown to be very sensitive to the quality of items made of compacted hydride-producing materials. A conclusion is drawn that diagnostics of these items is possible both before and during their operation. 4 refs.; 5 figs.

24273 (NIKHEF-K-AmPS–89-06) **Influence of RF-parameters on beam lifetime.** Kroes, F.B.; Maas, R. Nationaal Inst. voor Kernfysica en Hoge-Energiefysica (NIKHEF), Amsterdam (Netherlands). Sectie K. Aug 1989. 8p. Order Number DE90706069. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The Pulse Stretcher/Storage Ring AmPS will use a 2856 MHz RF system for the operation in Stretcher Mode. In order to obtain reasonable lifetimes in Storage Mode, a rather high RF voltage will be required at this frequency: at E = 900 MeV a voltage of V_{RF} = 710 kV is needed to create a bucket size of 7 σ_ϵ σ_ϵ being the equilibrium energy spread. At a lower frequency the RF voltage is less (e.g. when f – 500 MHz, only 140 kV is needed – at E = 900 MeV – to create the same bucket size). For this reason it is considered to add an additional low-frequency (e.g. f = 500 MHz) RF system for operation in Storage Mode. For commissioning purposes, however, the 2856 MHz system can be used for energies up to 650–700 MeV (author). 5 refs.; 6 tabs.

24274 (NIKHEF-K-DIGEL–1989-3) **120,000 V/μS.** Jansweijer, P.M.; Es, J.T. van. Nationaal Inst. voor Kernfysica en Hoge-Energiefysica (NIKHEF), Amsterdam (Netherlands). Sectie K. 1989. 31p. (In Dutch). Order Number DE90706072. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This report deals with the (im)possibilities of the various strategies which are followed to make a very fast 6000 Volt pulse (rise-and fall-time 50 nanseconds) (author). 5 refs.; 11 photos; 11 figs.; 3 tabs.

24275 (ORNL/FTR–3546) **[Ion sources for accelerators]: Foreign trip report, January 19, 1990–March 4, 1990.** Alton, G.D. Oak Ridge National Lab., TN (USA). 19 Mar 1990. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008549. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

To visit the Australian National University, Canberra, Australia, present a seminar on recent negative ion source developments, and tour the accelerator facility. To participate in the Second International Conference on nuclear microprobe technology and applications held in Melbourne, Australia, February 5–9, 1990, and present a paper on the emittances of ion beams extracted from gallium liquid metal ion sources. To participate in the International Workshop on Polarized Ion Sources and Polarized Gas Jets held in Tsukuba, Japan, February 12–17, 1990, and present a paper in the plenary session of the workshop on negative ion formation processes. To visit the Institute of Physical and Chemical Research (RIKEN), Wako, Japan, hold discussions with members of the plasma physics group on ECR sources concepts and applications, and tour the heavy ion accelerator facilities. To visit the Institute of Nuclear Studies (INS) of the University of Tokyo, Tanashi, Japan, to hold discussions with members of the accelerator facility staff on recent ECR ion source developments and to review progress made on the Tarn II synchrotron facility under construction. To visit the departments of electrical engineering and ion beam engineering of the University of Kyoto, Kyoto, Japan, present a seminar on recent ion source developments, and engage in discussions on ion sources and ion beam deposition problems and possible solutions. To visit the National Laboratory for High Energy Physics (KEK), Tsukuba, Japan, to witness experiments in progress related to the development of a direct- extraction, volume-type, high-intensity, multi-cusp, magnetic-field negative ion source.

24276 (ORNL/FTR–3564) **[Techniques used to produce radiation-resistant carbon stripper foils and obtain foils for testing]: Foreign trip report, March 7–17, 1990.** Auble, R.L. Oak Ridge National Lab., TN (USA). 2 Apr 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008981. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler visited the target preparation laboratory at the Technische Universita to study the use of laser-produced plasma techniques for the fabrication of carbon stripper foils. The reasons for the unusual behavior of the foils and the method used to produce them are given.

24277 (PEP-NOTE–381) **Tune shift and betatron modulations due to insertion devices in SPEAR.** Corbett, W.J. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Dec 1989. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (SSRL-ACD-NOTE–79). Order Number DE90008580. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

SPEAR will soon operate as a dedicated synchrotron radiation source with up to 5 beamlines fed from insertion devices. These magnets introduce additional focusing forces into the storage ring lattice which increase the vertical betatron tune and modulate the beam envelope in the vertical plane. The lattice simulation code 'GEMINI' is used to evaluate the tune shifts and estimate the degree of betatron modulation as each magnetic insertion device is brought up to full power. A program is recommended to correct the tunes with the FODO cell quadrupoles. 4 refs., 8 figs., 1 tab.

24278 (RAL–89-118) **User guide for the POLARIS powder diffractometer at ISIS.** Hull, S.; Mayers, J. Rutherford Appleton Lab., Chilton (UK). Nov 1989. 30p. Order Number DE90621885. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The POLARIS spectrometer at ISIS is currently being scheduled for use as a high intensity, medium resolution powder diffractometer. The particularly high neutron flux on POLARIS enables experiments to be performed with comparatively short counting times or on small sample volumes. This ability has been exploited during kinetic experiments of phase changes, where diffraction data is collected whilst the furnace is heating up. The provision of a large detector bank at 2 $\theta \approx 90^0$ is particularly important for studies of powder samples at high pressures. This scattering geometry has significant advantages for experiments of this kind, as suitable collimation of the incident and outgoing beams eliminates scattering from the surrounding pressure transmitting medium. This guide is intended to give a short description of the POLARIS powder diffractometer and to provide the basic information required to perform a powder diffraction experiment. (author).

24279 (RAL–89-120) **Neutron polarisation for ISIS.** Williams, W.G. Rutherford Appleton Lab., Chilton (UK). Nov 1989. 26p. Order Number DE90621886. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Scattering experiments using polarised thermal and cold neutron beams have made important contributions to condensed matter physics, particularly to the understanding of atomic magnetism. This has been largely due to the vigorous efforts made at reactor institutes to develop polarised beam technology; their success in this enterprise is now paying handsome dividends. Progress in developing comparable techniques for pulsed neutron sources has been slower, largely due to the greater practical difficulties associated with polarising higher energy neutrons. However, there has been some advance, and this has now provided clarification into the best ways of integrating the various polarising devices into pulsed source spectrometers. The status of polarised neutron spectrometers at pulsed neutron sources is reviewed. The paper deals with three main topics, the scientific relevance of polarised neutron scattering experiments, a discussion of the properties of neutron polarisers, emphasising their strengths and limitations, and the integration of polarisers into a range of ISIS pulsed source spectrometers. (author).

24280 (UCRL–100522) **A magnetically switched trigger source for FXR [Flash X-Ray].** Kirbie, H.C.; Otani, G.Y.; Hughes, G.M. Lawrence Livermore National Lab., CA (USA). Feb 1990. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890665–55: 7. Institute of Electrical and Electronics Engineers pulsed power conference, Monterey, CA (USA), 12-14 Jun 1989). Order Number DE90008543. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper describes the design and performance of a three-stage magnetic pulse compressor used to trigger the Flash X-Ray Accelerator at Lawrence Livermore National Laboratory. Each of

two compressors generates a pulse onto a bundle of thirteen parallel cables. The cables carry the pulse to a network of spark gaps that initiates the accelerator charge and discharge sequence. The performance data illustrate the compression of a 7.7-μs, dual- resonant waveform into a 232-ns(FWHM) unipolar pulse with an 80-ns risetime and a maximum dV/dt of 1.98 kV/ns. Additional data are also presented to show network jitter, efficiency, and sensitivity to small changes in charge voltage and reset current. 8 refs., 8 figs., 1 tab.

24281 (UCRL–102538) **Relativistic klystron afterburner simulation techniques.** Ryne, R.D.; Jong, R.A.; Westenskow, G.A.; Yu, S.S. Lawrence Livermore National Lab., CA (USA). 24 Jan 1990. 6p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CONF-900140–14: SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition, Los Angeles, CA (USA), 15-19 Jan 1990). Order Number DE90008539. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We are developing computer codes for the numerical simulations of relativistic klystrons and relativistic klystron "afterburners". The purpose of this note is to discuss the main features of our numerical model. A relativistic klystron "afterburner" is a scheme to extract power from a spent FEL electron beam. Power is extracted from the beam by passing it through klystron output cavities. To study the feasibility of this concept, we are developing computer codes for the numerical simulation of relativistic klystrons and afterburners. The purpose of this note is to discuss the main features of our numerical model.

24282 A shot parameter specification subsystem for automated control of PBFA II accelerator shots. Spiller, J.L. (Sandia National Labs., Albuquerque, NM (USA)). pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. IEEE Service Center, Piscataway, NJ (USA) (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The author reports on the shot parameter specification subsystem (SPSS), an integral part of the automatic control system developed for the Particle Beam Fusion Accelerator II (PBFA II). This system has been designed to fully utilize the accelerator by tailoring shot parameters to the needs of the experimenters. The SPSS is the key to this flexibility. Automatic systems will be required on many pulsed power machines for the fastest turnaround, the highest reliability, and most cost effective operation. These systems will require the flexibility and the ease of use that is part of the SPSS. The author discusses how the PBFA II control system has proved to be an effective modular system, flexible enough to meet the demands of both the fast track construction of PBFA II and the control needs of Hermes III. This system is expected to meet the demands of most future machine changes.

4304 Storage Rings

24283 (CERN–89-09) **The LEP main ring accelerating structure.** Wilson, I.; Henke, H. European Organization for Nuclear Research, Geneva (Switzerland). 8 Nov 1989. 45p. Order Number DE90621889. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A total effective voltage of more than 400 MV per turn is produced in the LEP main ring by 128 accelerating units. Each unit consists of a low-loss storage cavity coupled to a five-cell accelerating cavity. By driving the coupled system with its two resonant frequencies, the stored RF energy is made to oscillate between the two cavities in synchronism with the passage of the bunched beam. Since on average the energy spends one half of its time in the low-loss environment a substantial saving in power is obtained. This paper gives the basic theory associated with the design of this coupled-cavity system and reviews the main RF parameters. (orig.).

44 INSTRUMENTATION

4401 Radiation Instrumentation

Refer also to citation(s) 24038, 24113, 24312, 24332, 25018, 25066, 25139

24284 (BNL–43977) **Performance of the delayed- and prompt-gamma neutron activation systems at Brookhaven National Laboratory.** Dilmanian, F.A. (Brookhaven National Lab., Upton, NY (USA)); Weber, D.A.; Yasumura, S.; Kehayias, J.J.; Ellis, K.J.; Kamen, Y.; Lidofsky, L.; Heymsfield, S.B.; Pierson, R.N. Jr.; Wang, J. Brookhaven National Lab., Upton, NY (USA). [1989]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-8906269–7: 1989 international symposium on in vivo body composition studies, Toronto (Canada), 20-23 Jun 1989). Order Number DE90008817. Available from NTIS, PC A02/MF A01 - OSTI.

Brookhaven National Laboratory (BNL) is one of the major facilities pioneering the development of In Vivo Neutron Activation (IVNA) techniques for body composition studies. The IVNA facility at BNL includes a delayed- and prompt-gamma neutron activation system (DGNA and PGNA), as well as an inelastic neutron scattering facility (INS). The BNL DGNA system was first fully established in the 1960's. It is composed of a total-body neutron activation facility (TBNAF) and a whole body counter (WBC), and is used to measure total body sodium, phosphorus, chlorine, and calcium. Body potassium is measured by counting endogenous ^{40}K with the whole body counter. The DGNA and PGNA facilities have been upgraded and modified since they were first built. 6 refs., 4 figs.

24285 (CEA-CONF–9833) **Low level gamma spectrometry.** Pineira, T. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Protection contre les Rayonnements. 1989. 23p. (In French). (CONF-890207–: Waste management '89: 15th international waste management symposium conference, Tucson, AZ (USA), 26 Feb - 2 mar 1989). Order Number DE90762061. Available from NTIS (US Sales Only), PC A03/MF A01.

The low activity domain considered is below 0.01 Bq/cubic cm or Bq/g. Methods developed at the CEA to reduce background noise are examined, in particular protection against cosmic radiations, natural and artificial radionuclides. The low activity laboratory is described (buildings, ventilation, measurement chamber, shielding, very low activity lead, detector) and main results obtained are given.

24286 (CERN–89-10(v.1/2)) **ECFA study week on instrumentation technology for high-luminosity hadron colliders. Proceedings. Vol. 1 and 2.** Fernandez, E.; Jarlskog, G. (eds.). European Organization for Nuclear Research, Geneva (Switzerland); European Committee for Future Accelerators. 24 Nov 1989. 820p. (CONF-8909107–: ECFA study week on instrumentation technology for high luminosity hadron colliders, Barcelona (Spain), 14-21 Sep 1989; ECFA–89-124). Order Number DE90621998. Available from NTIS (US Sales Only), PC A99/MF A01; OSTI; INIS.

The main aim of the present ECFA Study Week on 'Instrumentation Technology for High Luminosity Hadron Colliders' was to review the progress made after the La Thuile Workshop (1987) and to critically evaluate which of the detection methods and data handling structures could be suitable for luminosities in the 10^{34} cm^{-2} s^{-1} range. The Study Week was sponsored by the Universitat Autonoma de Barcelona, the Comision Interministerial Ciencia y Tecnologia of Spain, CERN, and the Commission of the European Communities. It attracted 220 participants, including 35 from industry and good representation from groups planning experiments at the SSC. The various conveners gathered many excellent and original contributions, which led to intense discussions. Subjects covered include the use of scintillating fibres; silicon, gaseous, and crystal detectors, particle identification; readout and data acquisition systems. A separate session dealt with the contributions of industry to this kind of research. (orig.).

24287 (IAEA-TECDOC–537, pp. 47-56) **A detector array for PGNA analysis of industrial minerals.** Wormald, M.R. (UKAEA, Harwell (UK). Harwell Lab., Nuclear Applications Centre). International Atomic Energy Agency, Vienna (Austria). Jan 1990.

(CONF-8901184--: Advisory group on prompt gamma neutron activation analysis in borehole logging and industrial process control, Vienna (Austria), 30 Jan - 3 feb 1989). In *Prompt gamma neutron activation analysis in borehole logging and industrial process control: Report of an advisory group meeting held in Vienna, 30 January - 3 February 1989.* Order Number DE90621001. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

A gamma ray detection system is described which is suitable for the analysis of industrial minerals by the PGNAA technique. It consists of an array of NaI(Tl) scintillators which are operated as a pair spectrometer. Comparison with conventional germanium and NaI(Tl) detectors is made and the new system is shown to have significant improvements in performance. (author). 5 refs, 6 figs, 1 tab.

24288 (JINR–13-88-437) **Concept and equipment of high resolution time-of-flight trigger.** Azhgirej, L.S.; Vzorov, I.K.; Grebenyuk, V.M.; Kozhevnikov, Yu.A.; Kulinich, P.A.; Stoletov, G.D. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation. 1988. 6p. (In Russian). Order Number DE90622007. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The time-of-flight trigger system for MASPIC two-arm magnet spectrometer is described. The scintillation counter signals that are timing to charged particles hitting into counter are used for selection as input signals. The concept is based on the use of the coincidence method with programmable coincidence resolving time, delays and turning of channels. The PRAVETS-16 controls the system. The particle time-of flight is fixed by timing setup with a 300 ps accuracy. The coincidence circuit resolving time range can be fixed from 1 to 15 ns with pitch $\approx$ 65 ps. The delays are installed with the same accuracy. The system provides the effective separation of particles that time-of-flight difference exceed 1 ns. The work time is less than 50 ns. 8 refs.; 2 figs.

24289 (JINR–13-88-489) **Charged particle range detector based on proportional chambers.** Zanevskij, Yu.V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy); Peshekhonov, V.D.; Tyapkin, I.A.; Sitar, B. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1988. 6p. (In Russian). Order Number DE90621972. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A detector of charge particle range, based on proportional chambers is described. Detector was tested in alpha-particle beam with 200 MeV/nucleon energy. The detector provides high sensitivity of measurements on absorber density being equal to 0.1 %. 5 refs.; 7 figs.

24290 (JINR–13-88-567) **The parameters of the full absorption neutron spectrometer.** Konin, A.D.; Rudenko, A.I.; Fil'chenko, V.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 10p. (In Russian). Order Number DE90621979. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The methods of determination of the parameters of a scintillation neutron spectrometer are considered. Results for the parameters of the full absorption neutron spectrometer constructed in JINR (full scintillator volume V=24.1 l) and used in experiments studying muon catalysis process are presented. These parameters have been obtained from the analysis of the amplitude distributions measured with γ-sources of different energies and with neutrons selected from ^{238}Pu-Be spectrum using the TOF method. The value of $\sigma_{FWHM}=0.09(1+1/\sqrt{E_e})$ (MeV)) has been obtained for the amplitude resolution. It is two times better than that obtained for the detector having smaller size. The threshold energy of n-γ separation is equal to $E_\gamma^{thr} \simeq$ 50 keV what corresponds to the best results obtained with small detectors. 14 refs.; 6 figs.

24291 (JINR–13-88-627) **The elementary particle detection efficiency analysis by the coincidence method at small resolution times.** Kozhevnikov, Yu.A.; Lytkin, L.K. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 6p. (In Russian). Order Number DE90622008. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The computation version of elementary particle detection efficiency by coincidence method for comparable in value to counter timing error resolution times is described. The version is applied to all the types of timing error distributions including those obtained experimentally. The computation results estimating the relativistic particle detection efficiency by means of MASPIC detector scintillation counter system in the region of small (1.6-4 ns) resolution times are given. The time-of-flight (impulse) dependence at various timing errors and fitting accuracy of counter signal delay is shown. 3 refs.; 6 figs.

24292 (JINR–13-88-686) **Control system of GIBS spectrometer streamer chamber: Apparatus.** Bszeski, P. (Politechnika Warszawska, Warsaw (Poland). Inst. Radioelektroniki); Gaewski, K.; Glagoleva, N.S. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 10p. (In Russian). Order Number DE90622009. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The system intended for control of operation modes of a 2-meter streamer chamber and quality of experimental information with MERA-60 microcomputer and CAMAC instrumentation is described. Operator carries out the control of the chamber by measurement results and processing of signals from sensors and electronic circuits of chamber control. If the value of any parameter under control is outside the permissible deviation set by operator, then the system gives sound signal with a simultaneous indication of appropriate value on a terminal. 13 refs.; 2 figs.; 4 tabs.

24293 (JINR–13-88-687) **Software of GIBS spectrometer streamer chamber control system.** Bszeski, P. (Politechnika Warszawska, Warsaw (Poland). Inst. Radioelektroniki); Gaewski, K.; Glagoleva, N.S. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 9p. (In Russian). Order Number DE90622152. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Software of the control system of the 2-meter streamer chamber operating on-line with MERA-60 microcomputer is described, in which data reception, acquisition, analysis are performed, emergencies are registered. The data are displayed periodically of by operator's command as tables on a terminal, time functions and hysograms on colour TV screen, as well as protocols, time functions and histograms on DZM-180 printer. During a few years the system operates at the JINR synchrotron being a part of GIBS spectrometer. 3 refs.; 4 figs.; 1 tab.

24294 (JINR–13-88-757) **On stability of performance of the streamer chamber with controlled thermal centres.** Ivanovskij, S.A. (Joint Inst. for Nuclear Research, Dubna (USSR)); Konstantinov, K.R.; Lyashenko, V.I.; Sodnomyn, Eh.; Tran Anh Vu; Shcherbakov, Yu.A.; Tudor, T. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 7p. (In Russian). Order Number DE90622010. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Stability of the main parameters of the chamber with controlled thermal centres, such as track brightness and the gas bubble image diameter, are discussed in the paper. These parameters depend on the amplitude and delay of the pulses of Marx's generator and the laser illuminating the particle track, and on the gas mixture composition in the chamber. To monitor these parameters, a special electronic system is developed on the basis of the microcomputer KM-001. The equipment and some results obtained in the work are described. 9 refs.; 7 figs.

24295 (JINR-D–13-88-614) **The DELPHI hadron calorimeter module characteristics in the saturated proportional mode of its detectors operation.** Filatova, N.A. (Joint Inst. for Nuclear Research, Dubna (USSR)); Kadyrov, R.B.; Gotra, Yu.N. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 14p. Order Number DE90621999. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A preamplifier allowing an increase in the sensitivity of the already producted DELPHI Hadron Calorimeter front-end electronics up to 0.1 pC is described. The presented preamplfier permits a considerable reduction of the gas gain and transition to the saturated avalanche mode region. The HC barrel module characteristics in the proportional mode of its detectors operation are found out. The possibility of selecting muon track in the HC and using them for detector triggering has been investigated. It is shown that the transition to the proportional mode does not worsen the main characteristics of HC and the reliability of its detectors will be considerably incresed. 11 refs.; 11 figs.

24296 (JINR-D–13-88-764) **Basic parameters of the UCD microvertex detector.** Vodop'yanov, A.S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy); Golovatyuk, V.M.; Guzik, Z. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1988. 4p. (In Russian). Order Number DE90622000. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The parameters of the microvertex detector for the tracking system of the Universal Calorimetric Detector (UCD) intended for the experiments at the Serpukhov proton-proton collider are described. The microvertex detector consists of silicon wafers which are strip diode matrices working in fully depleted mode. It is used for high accuracy measurements of the decay vertices of secondary particles with a spatial resolution better than 3 μm. The parameters of readout electronics consisting of an amplifier and an analog dynamic memory based on charge-coupled devices are presented. Various technologies and the design of the detector and the readout electronics are considered. 15 refs.

24297 (JINR-E–13-88-566) **Registration efficiency of a full-absorption neutron spectrometer.** Fil'chenkov, V.V.; Marczis, L. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 12p. Order Number DE90621978. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A Monte-Carlo code was created and used for modellization of experimental spectra and of neutron registration efficiency by means of a large volume neutron detector (V=24.1). As is shown, n many cases simple estimations and calculations (also when threshold is taken into account) agree within a few %. Pulse height spectra at E_n=2.45, 4 and 5.2 MeV (at E_n=24.5 MeV also for deuterized scintillator) are presented. Results for a neutron detector with diameter 310 mm and length 160 mm used at JINR for investigations of muon catalysed fusion process d+d are demonstrated. 11 refs.; 8 figs.; 2 tabs.

24298 (JINR-E–13-88-729) **Mesooptical Fourier transform microscope for nuclear emulsion.** Batusov, Yu.A.; Bencze, G.L.; Soroko, L.M. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 6p. Order Number DE90622001. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Mesooptical Fourier Transform Microscope (MFTM) is a new coherent optical data processing system which gives an optical output signal only if a straight line appears in the input plane and can be used for searching straight lines in a complicated input picture. The principle of operation of the MFTM and its application for searching for tracks of elementary particles in nuclear emulsion are shown. 3 refs.; 3 figs.

24299 (JINR-R–1-88-408) **Polarimeter with a track detector.** Balandin, V.P. (Joint Inst. for Nuclear Research, Dubna (USSR)); Vitsev, V.V.; Belyaev, I.M. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 12p. (In Russian). Order Number DE90622002. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The polarimeter, on which basis the cumulative proton polarization in the inclusive reaction $p+A \rightarrow p_c+X$ was measured, is described. Measurements were made on the inner target of the U-70 proton accelerator (Serpukhov). Drift chambers were used as track detectors. 11 refs.; 14 figs.

24300 (JINR-R–1-88-414) **Organization of trigger for selection of cumulative protons on the base of programmed blocks for two-dimensional analysis.** Denisov, D.S. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij); Eroshin, O.V.; Polovnikov, S.A.; Kulinich, P.A.; Leitner, R.; Ol'shevskij, A.G.; Toledo, R. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 10p. (In Russian). Order Number DE90622003. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Organization of trigger on SIGMA-AJAX setup for selection of the process with the production of cumulative protons is described. The programmed blocks for two-dimensional analysis on the base of fast ADC are used. The time-of-flight and kinetic energy of particles are used for mass selection of protons and π-mesons by unit. The second unit is used to decrease the background effect. So, the time-of-flight information from a pair of scintillation counters situated at different distances to a target is analyzed. The usage of the second level trigger programmed units on the basis of fast ADC permits to decrease the trigger rate by 5-10 times and takes only 110 ns for analysis. 5 refs.; 9 figs.

24301 (JINR-R–1-88-516) **The characteristics of the drift chambers for muon spectrometer of the Neutrino detector setup.** Barabash, L.S. (and others); Baranov, S.A.; Gorbunov, N.V. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 8p. (In Russian). Order Number DE90622004. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Results of studies of the characteristics of large drift chambers for the setup Neutrino detector operating in a neutrino beam at the Serpukhov accelerator are presented. Pulsed high-voltage supply for the drift chambers is described. Comaparive characteristics of the drift chambers are given for constant and pulsed high voltages. The width of the plateau for the detection efficiency of tracks in the chambers is $\approx$ 100 V at an electronics threshold of 1 μA and the accuracy of detecting the tracks σ=1mm. The left-right ambiguity is a few per cent. Results of calculating the electric fields in a drift cell are presented. The conditions which allow one to improve the uniformity of the zones of electron collection on the sensitive wires are considered. 6 refs.; 12 figs.; 1 tab.

24302 (JINR-R–10-88-742) **Syndrome coding method for sequential systems of data processing in high energy physics spectrometers.** Nikityuk, N.M. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 12p. (In Russian). Order Number DE90622005. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The earlier developed method for syndrome coding of parallel systems of data registration and processing in high energy physics spectrometry is proposed to use in sequential devices such as ring counters and shift registers with logical feedback. Some examples of possible applications of ring counters with odd division coefficient as a circuit for logical signal delay and time mark registration are considered. For registration of single cluster events the coding devices are proposed to use for the Fire code correcrting error burst. Tables of generator polynomials which could be used to create effective coding devices are presented. 26 refs.; 4 figs.; 6 tabs.

24303 (JINR-R–13-88-485) **The Cherenkov method of simultaneous determination of the mean energy and direction of the 650 MeV proton beam.** Budyashova, S.Yu.; Zrelov, V.P.; Kuz'min, E.S. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 14p. (In Russian). Order Number DE90622006. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The paper presents the results obtained in the test of the Cherenkov method for simultaneous measurement of the mean energy and direction of a collimated 650 MeV proton beam from the phasotron of the Laboratory of Nuclear Problems. To make requirements to the proton beam intensity less strict, the Vavilov-Cherenkov radiation was registered in a wide range of wavelengths, and the LiF radiator dispersion effect was eliminated by an achromatic LK-4 glass prism. Equations and formulae are given to calculate parameters of a system like this. The test results have shown that the mean energy of protons can be determined with an accuracy of $\Delta E=\pm 0.2$ MeV; at the same time the beam ablique angle is measred with an accuracy of $\Delta_\alpha=\pm 25'$. 5 refs.; 9 figs.; 4 tabs.

24304 (JINR-R–13-88-770) **Experimental setup for investigation of atomic resonance fluorescence by the laser atomization of substance.** Gangrskij, Yu.P. (Joint Inst. for Nuclear Research, Dubna (USSR)); Zemlyanoj, S.G.; Markov, B.N.; Chan Cong Tam; Izosimov, I.N. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 6p. (In Russian). Order Number DE90622029. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to Prib. Tekh. Ehksp.

An experimental setup is described for investigating the laser resonance fluorescence of atoms in optical spectra. Substance evaporation is performed by using a powerful pulsed laser. A tunable dye-laser is used for atomic fluorescence. The setup operation and experments aimed to optimise its parameters are considered. The setup could be used to study a wide range of matter and its compounds, including the high-melting ones. 9 refs.; 5 figs.

24305 (LAPP-EXP–89-03) **Superheated superconducting aluminium and zinc granules for nuclear recoil detection.** Boniface, J.; Gonzalez-Mestres, L.; Perret-Gallix, D. Grenoble-1 Univ., 74 - Annecy (France). Lab. de Physique des Particules Elementaires. Mar 1989. 6p. (CONF-890199–: 24. Rencontre de Moriond on tests of fundamental laws in physics, Les Arcs (France), 21-28 Jan 1989). Order Number DE90762034. Available from NTIS (US Sales Only), PC A02/MF A01.

We discuss the possible use of Al and Zn superheated superconducting granules (SSG) as nucleus recoil detectors for solar neutrinos and dark matter. Recent results on superheating and sensitivity under irradiation are presented for collections of such grains. We also report possible evidence for thermal avalanche phenomena in collections of 4 micron average diameter Zn microspheres at T = 400 mK.

24306 (LAPP-EXP–89-05) **Crystal growth and characterization of $InBO_3$: Tb^{3+}.** Perret-Gallix, D. (Grenoble-1 Univ., 74 - Annecy (FR). Lab. de Physique des Particules); Gonzalez-Mestres, L.; Chaminade, J.P.; Garcia, A.; Pouchard, M.; Fouassier, C.; Jacquier, B. Grenoble-1 Univ., 74 - Annecy (France). Lab. de Physique des Particules Elementaires. Mar 1989. 10p. (CONF-8908217–: 9. international conference on crystal growth, Sendai (Japan), 20-25 Aug 1989). Order Number DE90762033. Available from NTIS (US Sales Only), PC A02/MF A01.

The growth of $InBO_3$: Tb^{3+} single crystals has been investigated in connection with a feasibility study of low energy neutrino detectors. $InBO_3$: Tb^{3+} crystals have been grown by slow cooling of high temperature solution using $LiBO_2$ as solvent. X-ray diffraction, optical study, chemical etching, chemical analysis were performed on the obtained single crystals. Luminescence properties of $InBO_3$: Tb^{3+} single crystals have been recorded.

24307 (LA-UR–90-472) **Wideband beam patterns from sparse arrays.** Anderson, F. (Anderson (Forrest), Bernalillo, NM (USA)); Fullerton, L.; Christensen, W.; Kortegaard, B. Los Alamos National Lab., NM (USA). 12 Jan 1990. 26p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900397–1: 1. Los Alamos symposium on ultra-wideband radar, Los Alamos, NM (USA), 5-8 Mar 1990). Order Number DE90007532. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Transient radiated fields due to impulsively excited apertures and aperture response due to incident impulsive waves has been the subject of considerable research in acoustics over the last decade. This research is also of importance to wideband radar. Medical ultrasound steered phased arrays use transmitted pulses consisting of from 1 to 3 cycles of a damped sinusoid, which is similar to certain radar systems. As will be shown, planar arrays using ultra-wide band pulses may be formed with very sparsely spaced elements. This makes feasible very high resolution, economical, and relatively simple, steered beam phased arrays. The resolution may be increased simply by moving the array elements further apart. Grating lobes due to aliasing are not formed when the elements are sparsely spaced. In a very sparse wide band array, element spacing effects the form, or signal shape in time, rather than the peak amplitude of the sidelobe structure. The number of elements in the aperture determines the peak sidelobe level which, in theory, may be decreased without limit. 13 refs., 7 figs.

24308 (NIKHEF-K-DIGEL–1989-5) **Compton amplifier.** Es, J.T. van; Verkooijen, J.C. Nationaal Inst. voor Kernfysica en Hoge-Energiefysica (NIKHEF), Amsterdam (Netherlands). Sectie K. 1989. 14p. (In Dutch). Order Number DE90706070. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A wide-band amplifier (60 Hz–2.3 MHz) with low noise (>80 dB) and galvanically separated inputs with an input sensitiveness of 1 microampere. The amplifier has been developed for amplifying the signals from the compton detectors. (author). 6 figs.

24309 (ORNL/FTR–3551) **[The traveler attended calorimeter working group]: Foreign trip report, February 23, 1990–March 11, 1990.** Plasil, F. Oak Ridge National Lab., TN (USA). 19 Mar 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008669. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler attended the L*/SSC meeting in Moscow and participated in the L* calorimeter working group. No major new conclusions were reached on L* calorimetry. The traveler spent one week at CERN. During the first part of the week, WA80 business was attended to. Preparations for the upcoming test beam appear to be progressing well. The second half of the week was devoted to participation in an L* calorimeter working group in which significant progress was made. On March 9, 1990, the traveler attended a meeting called by the CERN Director General, at which the future of the CERN heavy-ion program was discussed. It appears that CERN will be able to accelerate very heavy nuclei (e.g, Pb) to SPS energies by late 1993 or early 1994.

24310 **An area x-ray detector system based on a commercially available CCD-unit.** Fuchs, H.F. (Department of Chemistry, State University of New York at Stony Brook, Stony Brook, New York 11794-3400 (US)); Wu, D.Q.; Chu, B. *Review of Scientific Instruments (USA),* 61(2): 712-716 (Feb 1990).

A two-dimensional x-ray detector has been developed by combining a fiber-optic face plate (FOFP) which was deposited with a thin layer of phosphor (Y_2O_2S:Tb), a high-quality camera lens, and a slow-scan fiber-optics (FO) bonded charge-coupled device (CCD) camera system. The detector showed good linearity of response to the incident x-ray intensity and good spatial linearity. It had an effective area on the phosphor screen of 31.5 mm x 47.2 mm. Low CCD dark count allowed up to about 30 min of continuous measurement. No radiation damage was detected, even for measurements of the synchrotron x-ray main beam. However, the detector quantum efficiency was low (~25%), and the bonding between the FO and the CCD was very fragile, so that the chicken wire pattern produced by the bonded FO introduced a 5% error in detector sensitivity which was difficult to correct. However, such a detector with a non-FO-bonded CCD camera system instead of the FO-bonded CCD system should be ideal for extended x-ray absorption of fine structure (EXAFS) experiments.

4402 Radiation Effects on Instrument Components, Instruments, or Electronic Systems

24311 (JINR-R–2-88-615) **Simulation of induced radioactivity in collimating materials under cosmic proton irradiation.** Barashenkov, V.S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation); Sosnin, A.N.; Taranenko, P.I.; Fedotov, S.N. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation. 1988. 11p. (In Russian). Order Number DE90622150. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

γ-ray spectra from lead and tungsten targets irradiated by cosmic protons, corresponding to close-to-earth orbits, are calculated using Monte-Carlo method. The influence of South-Atlantic anomaly is taken into account. Prompt radiation (in the interval of 10^{-6} to 10^{-15} s) and γ-radiation from induced activity have been studied depending on exposure time (in the interval from several days up to one year). The induced γ-activity is of the same value as the background radiation, however, in some cases it is somewhat higher than the background. 9 refs.; 9 figs.

4404 Well Logging Instrumentation

Refer also to citation(s) 23633, 24039, 24040, 24435, 24440, 24792, 24799, 24800

4405 Thermal Instrumentation

24312 (UCRL–102559) **A new thermal sensor for x-ray microcalorimetry.** Silver, E.; Labov, S.; Pfafman, T. Lawrence Livermore National Lab., CA (USA). 2 Feb 1990. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-891276–6: Workshop on high energy astrophysics in the 21st century, Taos, NM (USA), 10-14 Dec 1989). Order Number DE90008547. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Photon counting x-ray spectroscopy using microcalorimeters combines the high resolution power of a Bragg crystal with the

broad bandwidth capability and high efficiency of charge sensitive detectors. To date, the developers of microcalorimeters take advantage of the strong temperature dependence of resistance in doped semiconductor crystals for converting the calorimeter temperature changes into useful voltage signals. Resistive sensors limit the ultimate sensitivity of microcalorimeters because they dissipate heat and add Johnson noise to the electronic conversion circuit. Potentially, these detrimental properties can be eliminated by exploiting the temperature dependence of the dielectric constant in ferroelectric materials. A mixed crystal quantum ferroelectric shows great promise for a dielectric thermal sensor. We present results from our most recent measurements which include the first detection of individual 6 MeV alpha particles with a dielectric calorimeter operating at 1.2 K. 2 refs., 5 figs.

4406 Optical Instrumentation

Refer also to citation(s) 23627, 23876, 24341, 24343

24313 (BARC–1440) **Design and fabrication of a polychromator using Paschen-Runge mount.** Shukla, R.P.; Murty, P.S.; Biswas, S.S.; Rao, P.K.S.P.; Sankaran, A.V.; Krishnamachari, S.L.N.G. Bhabha Atomic Research Centre, Bombay (India). 1988. 12p. Order Number DE90622042. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The design and fabrication of a polychromator for the wavelength range 2000 A to 4000 A is described. It consists of a holographic concave grating of radius of curvature 1 metre and frequency 2160 grooves/mm. The Paschen-Runge type of mount was chosen because it has a wider spectral range. Holographic diffraction grating was chosen to reduce the amount of stray radiations and eliminate completely the ghosts. The linear reciprocal dispersion on the Rowland focal surface is about 4.6 A/mm. The resolution of the polychromator is about 0.25 A. Seven slits are fixed precisely on the Rowland circle to the corresponding wavelength positions of certain sensitive lines of the elements Cd, Ni, Co, B, Mn, Mg, and Cr. The radiation of each wavelength is detected by the photomultiplier tubes. The polychromator will be used with inductively coupled plasma (ICP) as a source of excitation for the detection of impurities Cd, Ni, Co, B, Mn, and Cr in different type of samples. (author).

24314 (CONF-900451–1) **Nonlinear filter derived from topological image features.** 21Jatko, W.B.; Hunt, M.A.; Tobin, K.W. Oak Ridge National Lab., TN (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Technical symposia on optical engineering and photonics in aerospace sensing; Orlando, FL (USA); 16-20 Apr 1990. Order Number DE90008555. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A digital machine-inspection system is being developed at Oak Ridge National Laboratory for detecting flaws on printed graphic images. The inspection is based on subtraction of a digitized test image from a reference image to determine the location, number, extent, and contrast of potential flaws. When performing subtractive analysis on the digitized information, two sources of errors in the amplitude of the difference image can develop: (1) spatial misregistration of the reference and test sample or, (2) random fluctuations in the printing process. Variations in printing and registration between samples will generate topological artifacts related to surface structure, which is referred to as edge noise in the difference image. Most feature extraction routines require that the difference image be relatively free of noise to perform properly. A novel algorithm has been developed to filter edge noise from the difference images. The algorithm relies on the a priori assumption that edge noise will be located near locations having a strong intensity gradient in the reference image. The filter is based on the structure of the reference image and is used to attenuate edge features in the difference image. The filtering algorithm, consisting of a geometric transformation, image multiplication, and erosion/dilation, has reduced edge noise by 67% over the unfiltered image and can be implemented using off-the-shelf hardware. 4 refs., 6 figs.

24315 (SAND–0494C) **An infrared imaging area sensor for tactical and physical security applications.** Pritchard, D.A. Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 13p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900396–2: IRIS Specialty Group meeting on passive sensors and atmospheric physics, Laurel, MD (USA), 13 Mar 1990). Order Number DE90008727. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Thermal imagers are effective tools for detecting aggressive actions and enhancing physical security in both tactical and peacetime environments. However, from an operator's perspective, these devices are rarely used on a continuous basis because of inconvenience and a requirement to have the operator be the "detector" while using the imager as a sensor. This paper describes an area sensor and assessment system designed to reduce operator fatigue and improve the effectiveness of costly thermal imagers. Several prototypes have been installed and operated at sites worldwide. The device uses a thermal imager as the primary sensor but also incorporates a laser rangefinder, automatic area precision scanning, robust scan-to-scan scene change detection, a deliberate-motion detection features. The system setup, control, and alarm assessment functions of the operator console are described. The digital processing is discussed and performance measures are given. 2 refs., 7 figs.

24316 (UCRL–15720) **Laser isotope separation SISL project conceptual design study: Final report.** Eastman Kodak Co., Rochester, NY (USA). U.S. Apparatus Div. 10 May 1984. 99p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008532. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This study resulted in a conceptual design for the Combination Wall Telescope. Optical element thermal distortions due to axisymmetric laser irradiation are restricted to budgeted values by means of passive techniques. Thermally-conductive mirror mounts were designed to reduce temperature gradients to acceptable values. Analysis demonstrated that laser beam spot sizes on optical elements should be one centimeter minimum for a 2.5 watt absorbed load. The optical design activity resulted in a modification of the LLNL concept. The optical form is relatively insensitive to element tilt, despace and decenter tolerances. The design resulted in a relatively narrow 125 microradian field-of-view and is susceptible to beam walk across elements. Thus, telescope body pointing and constant input beam direction are important issues. 84 figs.

24317 (UCRL–101575) **Experimental validation of extended image reconstruction using bispectral speckle interferometry.** Lawrence, T.W.; Fitch, J.P.; Goodman, D.M.; Massie, N.A.; Sherwood, R.J. Lawrence Livermore National Lab., CA (USA). Jan 1990. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900285–2: SPIE astronomical telescopes and instrumentation for the 21st century symposium, Tucson, AZ (USA), 11-17 Feb 1990). Order Number DE90008545. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Results will be presented from a horizontal path imaging experiment in which we used a 0.5 meter telescope focused on a target located at a range of 1.2 km. The targets included various extended objects from a simple binary letters to extended representations of satellites with grey scale and size variations. Imaging at a center wavelength of 0.7 microns, we found an atmospheric degradation factor of $D/r_o = 17$, on average. We used a slow readrate bare CCD detector and thus had to effectively deal with additive noise in the speckle measurements. Our image reconstruction algorithms are based on the use of the complex bispectrum and we have demonstrated diffraction-limited imaging down to light levels approaching a few photons per speckle resolution area. We have paid careful attention to the effects of additive noise on the reconstruction process and shown that they can be adequately overcome. 11 refs., 8 figs.

24318 (UCRL–102996) **Simple reflection holography.** Toeppen, J. Lawrence Livermore National Lab., CA (USA). 29 Mar 1990. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-9003106–1: Spring optical show of the Optical Society of Northern California, Palo Alto, CA (USA), 29

Mar 1990). Order Number DE90008309. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

White light reflection holography is a good starting point for the first time holographer. The building of an inexpensive holographic camera offers an approach that has many distinct advantages. Not only can such a device be constructed by the average craftsman at a minimum cost but the monolithic design helps assure good results. The finished images are reasonably bright and easy to view in sunlight. The building of the camera itself is instructional as a design task which considers practical problems and scientific principles. The convenience of the finished device avoids many of the difficulties in setting up a dedicated optics lab. Further, the satisfaction of producing quality holograms is reinforced by a tangible reward for successful efforts. Methods, rather than theory, are the essence of this paper. It is intended that this project is not only an end in itself but that it serves as a basis for an outlook towards practical science. 7 refs., 3 figs.

24319 **Experimental observation and suppression of transverse stimulated Brillouin scattering in large optical components.** Murray, J.R. (Lawrence Livermore National Laboratory, University of California, P.O. Box 5508, Livermore, California 94550 (US)); Smith, J.R.; Ehrlich, R.B.; Kyrazis, D.T.; Thompson, C.E.; Weiland, T.L.; Wilcox, R. *Journal of the Optical Society of America, Part B: Optical Physics (USA),* 6(12): 2402-2411 (Dec 1989). DOE Contract W-7405-ENG-48.

Using 2.4-nsec pulses at 350 nm, we have observed transverse stimulated Brillouin scattering (SBS) in fused-silica optical components. Transverse SBS sets in when the product of laser fluence and growth time for the scattered optical wave exceeds ~2.3 J nsec/cm^2. An increase in laser bandwidth to 8.3 GHz suppresses SBS losses up to approximately twice the SBS threshold. We review the theory of transverse, broadband SBS and its scaling with experimental parameters.

4408 Miscellaneous Instrumentation

Refer also to citation(s) 23770, 24183, 25249, 25254

24320 (JINR-R-7-88-596) **The study of ion-optical characteristics of LIDIA mass-spectrometer.** Bogdanov, D.D.; Bondarenko, P.G.; Gusev, V.P.; Petrov, D.V.; Rodin, A.M.; Sidorchuk, S.I.; Stepantsov, S.V.; Ter-Akopyan, G.M.; Timakov, V.A. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 15p. (In Russian). Order Number DE90622046. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The results of the experiments on shaping the magnetic fields of ion-optical elements of LIDIA ultrasensitive mass-spectrometer designed to search for superheavy elements (A>250) using a laser ion source and a multistage separation system are presented. The main ion-optical characteristics of the device (acceptance, dispersion, resolution, line shape) are measured by means of ^{249}Cf and ^{226}Ra α-particle beams. A good agreement of the obtained results with the calculated ones is shown. 16 refs.; 9 figs.; 7 tabs.

24321 (JINR-R-13-88-750) **Remote controlled NMR magnetometer.** Bienkowski, A. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 4p. (In Russian). Order Number DE90622045. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Remote controlled device for measuring the induction of homogeneous magnetic field is described. Principle of operation is based on using nuclear magnetic resonance. The induction range of 0.59-1.31 T is measured with one field detector. The accuracy of 1.5×10^{-5} T is achieved. The NMR signal-to-noise ratio throughout the total range is above 10:1. 1 refs.; 1 fig.

24322 (NIKHEF-K-DIGEL-1989-4) **Digital to position converter.** Es, J.T. van; Kruijer, A.H. Nationaal Inst. voor Kernfysica en Hoge-Energiefysica (NIKHEF), Amsterdam (Netherlands). Sectie K. 1989. 16p. (In Dutch). Order Number DE90706071. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This report deals with a digitally controllable servosystem for the regulation of a mechanical movement. The system has been applied, as prototype, to the phase rotator in the driver of the klystron of station 13 (NIKHEF K), and to the reducer at the output of this klystron. Control and supply takes place from a Camac-module, Borer type 1084A. (author). 6 figs.

24323 **Experimental study of a high-frequency megawatt gyrotron oscillator.** Kreischer, K.E.; Grimm, T.L.; Guss, W.C.; Mobius, A.W.; Temkin, R.J. *Physics of Fluids B (USA),* 2(3): 640-646 (Mar 1990).

A detailed experimental study of the efficiency and output power of a pulsed gyrotron operating in the $TE_{16,2,1}$ mode at 148 GHz has been conducted. A peak efficiency of 30% was achieved at 80 kV and 20 A for an output power of 480 kW. The highest output power of 925 kW, corresponding to an efficiency of 19%, was measured at 120 kV and 40 A. Two cavities with different interaction lengths (6.0λ and 4.2λ) were investigated. In both cases, agreement was found between the theoretical and experimental efficiency for beam currents up to 15–20 A. At higher currents, the experimental efficiency saturated between 20% and 25%, well below the 35%– 40% predicted by theory. No increase was obtained for modest positive or negative linear tapering of the cavity magnetic field. Measurements indicate that the beam velocity ratio decreases as beam current increases, partially explaining the reduced efficiency at higher currents. Operation in different azimuthal rotations of the cavity modes was also observed. The measured rotation was found to be consistent with the theoretical coupling between the beam and rf field.

24324 **Imaging of biomolecules with the scanning tunneling microscope: Problems and prospects.** Salmeron, M. (Lawrence Berkeley Laboratory, Berkeley, California 94720 (USA)); Beebe, T.; Odriozola, J.; Wilson, T.; Ogletree, D.F. *Journal of Vacuum Science and Technology, A (Vacuum, Surfaces and Films) (USA),* 8(1): 635-641 (Jan 1990). DOE Contract AC03-76SF00098.

The capabilities of the scanning tunneling microscope as a tool to study the morphology and structure of adsorbed biomolecules are reviewed in view of recent experimental results. Problems such as electrical conductivity of the biomolecules, fixation to the substrate and identification are analyzed in detail. In particular, the role of tip–surface interaction giving rise to repulsive forces is illustrated. It is concluded that fixation rather than conductivity is the major obstacle to the use of the STM for biological imaging.

45 MILITARY TECHNOLOGY, WEAPONRY, AND NATIONAL DEFENSE

Refer also to citation(s) 23834, 24315

24325 (AD-A-215137/1/XAB) **Terminating major war in Europe. Final report.** Scott, J.F. Army War Coll., Carlisle Barracks, PA (USA). 17 Nov 1989. 107p. Available from NTIS, PC A06/MF A01.

This essay addresses termination of major war in Europe, where potential escalation to use of nuclear weapon has become a conspicuous but necessary aspect of our strategy and structure. The author takes the war termination objective from its origins in the major European war context and develops the implied concepts, determinants of escalation, and elements of termination theory. He then examines the strategy and force structure of opposing sides in Europe to illuminate some of the key issues surrounding this often neglected but fundamental aspect of military strategy. He contends that, although termination is the only politically sensible objective in a major war between the superpowers, NATO's political organization and force structure do not currently provide the flexibility needed to effect termination decisions. Termination is the objective of choice for the United States and NATO, he concludes, but it may still be only a policy waiting for a corresponding strategy and structure. This document reviews the main points addressed in developing a termination theory and evaluating NATO strategy and structure from a U.S., Alliance and Soviet standpoint. It then describes the military implications arising from this evaluation, as well as military tasks corresponding to a viable termination strategy. Finally, it discusses a few issues that might concern military commanders because of the political and military requirements of termination.

24326 (AD-A–215520/8/XAB) **Superconductive analog signal-processing devices.** Withers, R.S.; Ralston, R.W. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. Aug 1989. 19p. (JA–6262). Available from NTIS, PC A03/MF A01.

Pub. in Proceedings of the IEEE, Vol. 77, No. 8, 1247-1263(Aug 1989).

Real-time signal processing is stressed in many emerging applications, such as pulse-compression radar, spread-spectrum communications, and electronic warfare. The required digitally equivalent computational rate for these applications is on the order of 10(12) arithmetic operations per second and the required instantaneous bandwidths could approach 10 GHz. These exceed by nearly three orders of magnitude the capabilities projected for digital systems in the near future, and even exceed that of recently developed analog technologies, such as surface-acoustic-wave (SAW) signal-processing devices. To meet anticipated future system bandwidths exceeding 2 GHz have recently been realized and the technology is being developed for the realization of 10-GHz bandwidths.

24327 (PB–90-146861/XAB) **Joint nuclear weapons development studies and engineering projects. Directive.** Gilson, J. Office of the Under Secretary of Defense (Acquisition), Washington, DC (USA). 27 Dec 1983. 11p. (DOD-D–3150.1). Available from NTIS, PC A03/MF A01.

The Directive replaces DoD Directive 5030.2 and updates policy, procedures, and responsibilities for conducting joint Department of Energy (DOE)-DoD nuclear weapons concept definition studies, feasibility studies, and design definition and cost studies; for handling nuclear weapon development engineering projects; and for developing and transmitting nuclear weapons military characteristics and stockpile-to-target sequence to the DoE.

24328 (UCID–21762) **The Security Exercise Evaluation Simulation (SEES) addendum: Version 1.1.** Dobbs, L.A.; Calloway, D.R.; Elko, S.D.; Grum, H.G.; Parrett, J.W.; Pimper, J.E.; Uzelac, M.J. Lawrence Livermore National Lab., CA (USA). c 1 Sep 1989. 70p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Available from Lawrence Livermore National Laboratory, University of California, P.O. Box 808, Livermore, CA 94550.

The SEES system of hardware and software provides the capability to examine new safeguards technology and methods of protecting secure sites. Using high resolution graphics, intelligent workstations, distributed processing, and real time play, users can examine the effects of new technology and tactics. Commanding officers and their staffs can refine the decision making process while developing and testing realistic plans. SEES is an interactive, squad level, two sided simulation created to explore relationships of combat and tactical processes in an urban environment – using a standalone, event sequenced, stochastic, computer simulation. SEES has been developed to function as both an analytical tool and a training simulation allowing: evaluation of site security systems; evaluation of tactics and alternative force structures; stimulation of creative thinking to produce new ideas, and provision of a training environment for commanding officers of small armed forces. The SEES simulation system models combat systems, the urban (site) environment, and each system's interaction with other systems and their environment. The SEES system was developed using the Janus system as a baseline, therefore, there are a lot of common capabilities and functions. The system is written in FORTRAN, running on any of the VAX family of Digital Equipment Corporation computers under the VMS operating system. The computer processes the numerical calculations required for an item level simulation in or near real time to support a simulation running on up to 8 Tektronix graphics workstations with one or two players per workstation. The computational load placed on the computer is greatly reduced due to the distributed processing of graphics at each individual graphics workstation.

4501 Chemical Explosions and Explosives

24329 (MLM–3627) **Maximum credible event determination for a DuPont detonator, DFP-8, and its handling container.** Jones, R.B. EG and G Mound Applied Technologies, Miamisburg, OH (USA). 7 Mar 1990. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-88DP43495. Order Number DE90008177. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An investigation was done to determine the maximum credible event value for a DuPont detonator, DFP-8, when stored and moved in a specially designed handling tray and storage container. To determine this value, a propagation test was performed. The test was satisfactorily completed with no propagation or fragment excursion evident. 13 figs.

24330 (MLM–3629) **TATB [triaminotrinitrobenzene] purification and particle size modification: An evaluation of processing options.** Firsich, D.W.; Thorpe, R.; Cox, L.A. EG and G Mound Applied Technologies, Miamisburg, OH (USA). 15 Mar 1990. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-88DP43495. Order Number DE90008176. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Triaminotrinitrobenzene (TATB) is an insensitive high explosive with desirable safety characteristics. Mound is currently interested in developing a high purity, high surface area form of this compound to increase its potential applications. This paper describes recent development efforts. After setting purification and surface area goals, a number of processing procedures were tested to determine their practicality and effectiveness. The purification procedures included sulfuric acid recrystallization, dimethylsulfoxide/NaOH recrystallization, Soxhlet extraction, thermal gradient sublimation, and high-temperature recrystallization. Techniques identified for increasing surface area included crash precipitation of TATB and processing TATB in a fluid energy mill. An evaluation of the data suggested that a two- or three-step process will be necessary to produce the desired results. A sulfuric acid recrystallization used in conjunction with a high-temperature recrystallization is recommended to achieve the necessary purity. This should be followed by a crash precipitation or milling step to meet surface area requirements. 5 refs., 5 figs., 1 tab.

24331 (SAND–89-2580C) **Shock initiation sensitivity of damaged TP-H1207C composite propellant.** Weirick, L.J. Sandia National Labs., Albuquerque, NM (USA). [1989]. 15p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9004147–2: 1990 JANNAF propulsion systems hazards meeting, Laurel, MD (USA), 3-5 Apr 1990). Order Number DE90008509. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A series of impact experiments on a composite and an energetic propellant and their simulants was recently completed using a light-gas gun. Previous experiments were done to obtain Hugoniot data, to investigate the pressure threshold at which a reaction occurs, to measure spall damage at various impact pressures, and to measure the shock attenuation of these materials. Recently, digitizing oscilloscopes with very high speed (1 GHZ/1 ns per point), improved vertical resolution (8 bit), and large storage capacity (62 K points) have been added to our laser interferometer system. These additions have made possible the accurate measurement of the magnitude of impacts with very short loading histories (~50 ns) which may be followed by long delay times (~15 μs) before a reaction is initiated or a subsequent impact occurs. Experiments have been performed where a flyer plate on the front of a projectile induced an initial shock of 1.94 GPa through a composite propellant, TP-H1207C, target producing a damaged propellant. After an induced delay of ~4.5 μs, a second impact shock is imposed into the damaged propellant possibly causing it to react. By using secondary impactors of various impedances, the second impact pressure can be lowered until the damaged propellant no longer reacts. This pressure is the initiation threshold pressure for the damaged propellant. For the case of TP-H1207C initially subjected to a 1.94 GPa pressure pulse, the sensitized material initiation threshold was found to be 1.46 GPa. This value contrasts with the previously measured initiation threshold of ~4.1 GPa for undamaged TP-H1207C. 13 refs., 4 figs., 4 tabs.

24332 (UCRL-ID–103318) **High explosives (PBX9502) characterization using computerized tomography.** Martz, H.E. (Lawrence Livermore National Lab., CA (USA)); Roberson, G.P.; Skeate, M.F.; Schneberk, D.J.; Azevedo, S.G.; Lynch, S.K.

Lawrence Livermore National Lab., CA (USA). 14 Feb 1990. 104p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008170. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

X-ray computed axial tomography (CAT or CT) is an advanced imaging technique which provides three-dimensional nondestructive inspection and characterization of materials, components and assemblies. The Lawrence Livermore National Laboratory (LLNL) and the Mason & Hanger-Silas Mason Co., Pantex Plant are cooperating to examine the use of CT Technology to inspect high-explosive (HE) pressings. The goals of this joint project are to study the HE pressing process using computed tomography scanners, to provide a foundation for the further development of industrial CT scanners, and to work with the private sector on the design and implementation of an automated CT inspection scanner to be used in the manufacturing process of high explosives at the Pantex Plant. The early detection of defective HE pressings will reduce the cost and improve the safety of the high-explosives production cycle. At present, all pressings are bulk density tested. In addition, samples are randomly selected from each pressing lot for destructive core sampling to obtain an estimate of internal density gradients. CT is a viable technology for a high-explosives inspection system. CT measures density variations, detects foreign inclusions and voids with a probability of detection as good as or better than present inspection techniques. In addition, CT can be fully automated to allow for a 100% sample inspection. LLNL has the advantage of several different in-house built CT scanners to bring to bear on the inspection of high explosives. A preliminary study was performed to evaluate the LLNL CT scanners and prove the characterization principles associated with CT on small PBX9502 high-explosive samples. This paper summarizes the results obtained, and introduces the capabilities of LLNL's Nondestructive Evaluation Section CT scanners. 36 refs., 50 figs.

4502 Nuclear Explosions and Explosives

24333 (AD-A–215526/5/XAB) **X-ray performance of multilayer diffraction diagnostics. Memorandum report.** Burkhalter, P.G.; Freitag, R.K.; Gilfrich, J.V.; Brown, D.B.; Rosenstock, H.B. Naval Research Lab., Washington, DC (USA). 13 Nov 1989. 26p. (NRL-MR –6574). Available from NTIS, PC A03/MF A01.

X-ray spectroscopy is an established diagnostic for the Nuclear Test Program. The high diffraction response of multilayer structures can make important contributions as X-ray diffraction analyzers for UG testing. The soft X-ray performance of a number of commercially deposited multilayers was determined in our laboratory and compared with diffraction theory predictions.

24334 (SAND–87-1734) **SANDUS [SANdia Digital Underground System] checkout procedure.** Werling, D.K. Sandia National Labs., Albuquerque, NM (USA). 27 Nov 1989. 43p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC04-76DP00789. Order Number DE90007902. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This set of procedures is designed to guide an operator through the complete SANDUS (Sandia Digital Underground System – MA164 Digital Data Acquisition System) system checkout. Each piece of Common Equipment is operationally checked by following this procedure. These steps should be performed in their entirety prior to each Nevada test Site (NTS) event. It is assumed the operator has the experience with the SANDUS and the program DHTEST to run these procedures. 5 figs.

24335 (SAND–90-0751C) **New material sampling rationale.** Hahn, R.F. Sandia National Labs., Albuquerque, NM (USA). [1990]. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9004146–3: 16. DOE compatibility, aging and service life conference, Livermore, CA (USA), 24-26 Apr 1990). Order Number DE90008502. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper explains the newly implemented new material (NM) sampling rationale for weapon production developed by Frank W. Mueller, SNL/7266, and approved by DOE. Our experience with weapon production programs has been primarily limited to production lengths of five years or less. As more recent programs, such as the W80, are moving toward increasingly longer production phases, it has become apparent that our previous sampling rationale may have required excessive new material samples. 3 refs.

24336 (UCRL–21299) **Applications of discrimination methods to high frequency seismic data: Final report.** Archambeau, C.B. Colorado Univ., Boulder, CO (USA). 15 May 1989. 57p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008784. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The main objectives of the work reported here are not only to provide a good, physically sound, basis for the interpretation of past observational data but also to provide a theoretical basis for the interpretation of very high frequency seismic data at regional distance ranges. In particular, we are attempting to lay a theoretical basis for the definition of discrimination methods using high frequency seismic observations in the regional distance range. Further we wish to establish methods, and an understanding of the methods, for yield estimation in the near and regional distance ranges using broad band seismic data with a band-width from very low frequencies. In this first part of the work reported here we have developed a very general dynamical description of the seismic radiation from earthquakes. Our objective is to provide a more complete understanding of the character of the radiation from such events and to provide a predictive capability, to aid us in establishing and understanding discrimination methods at high frequencies in regional distance ranges. In the second part of this study we have analyzed seismic data from underground nuclear explosions in an effort to devise a suitable source model. In particular, observations of the spectral character of direct compressional waves from underground nuclear explosions. 20 refs., 9 figs.

4503 Nuclear Explosion Detection

Refer also to citation(s) 23898

4504 Nuclear and Radiological Warfare

Refer also to citation(s) 23835, 23836

4505 Strategic Defense Initiative

Refer also to citation(s) 23835, 23836

24337 (AD-A–215440/9/XAB) **Delta 181 Sensor Module Command Center. Technical memo.** Heins, R.J.; Chacos, A.A.; Hermes, M.J. Johns Hopkins Univ., Laurel, MD (USA). Applied Physics Lab. Sep 1989. 34p. Available from NTIS, PC A03/MF A01.

In February 1988 an APL-designed sensor module was launched into orbit and performed a number of significant SDI Delta 181 program experiments. Sensor module on-orbit command and control operations involved a network of worldwide facilities called the control complex. A major component was the sensor module command center, which was designed, installed, and operated by APL. This document presents an overview of command center system design. Particular emphasis is given to the hardware design and interface to worldwide assets. Pertinent detail of the Delta 181 control complex and command center mission operations is given to place the design in overall context. The command center design is described within the context of the Delta 181 mission. After completion of the Delta 181 mission, a modified version of the command center was used to successfully support the Delta Star mission in March 1989. Mission control center and network design concepts developed for these programs is being carried over to ongoing development of similar applications.

24338 (AD-A–215665/1/XAB) **Empirical development of parallelization guidelines for time-driven simulation. Master's thesis.** Huson, M.L. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Dec 1989. 191p. (AFIT/GCS/ENG–89D-10). Available from NTIS, PC A09/MF A01.

Distributed simulation is an area of research which offers great promise for speeding up simulations. Program parallelization is usually an iterative process requiring several attempts to produce an efficient parallel implementation of a sequential program. This is

due to the lack of any standards or guidelines for program parallelization. In this research effort a Ballistic Missile Defense (BMD) time-driven simulation program, developed by DESE Research and Engineering, was used as a test vehicle for investigating parallelization options for distributed and shared memory architectures. Implementations were developed to address issues of functional versus data program decomposition, computation versus communications overhead, and shared versus distributed memory architectures. Performance data collected from each implementation was used to develop guidelines for implementing parallel versions of sequential time-driven simulations. These guidelines were based on the relative performance of the various implementations and on general observations made during the course of the research.

24339 (AD-A–215681/8/XAB) **Defending against a space blockade. CADRE paper.** Blow, T. Air Univ., Maxwell AFB, AL (USA). Airpower Research Inst. Dec 1989. 24p. (AU-ARI-CP–89-3). Available from NTIS, PC A03/MF A01.

Although great attention has been paid to space weapons in relation to the Strategic Defense Initiative, there seems to be little recognition that platforms performing an SDI role could establish a space blockade. The United States must recognize the feasibility of such a blockade and take steps to offset it. Possible steps include depending on arms control pacts to keep weapons out of space, developing terrestrial systems for use in breaking a blockade, or putting weapons in space before an adversary can establish a blockade. Problems in verifying the nature of orbiting vehicles reduce the reliability of arms control. Advantages space weapons will have over surface-based systems argue against dependence on restorative measures undertaken from the ground. Thus, putting weapons in space is an option that should be explored. Perhaps the most cogent argument against this option is that using space for military ends may be destabilizing. Merely placing U.S. weapons in low orbit, even if they were deployed solely for SDI, would threaten rivals because of the possibility of a US blockade. Moreover, such platforms would be vulnerable if another power put weapons in orbit. However, a mix of low-orbit SDI forces and high-orbit reserve forces should be less vulnerable and less threatening. Such a defense could be improved by creating a high-orbit keep-out zone for each space power.

24340 (AD-A–215728/7/XAB) **Expert system for automating nuclear-strike-aircraft replacement, aircraft beddown, and logistics movement for the Theater Warfare Exercise. Master's thesis.** Harken, H.D. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Dec 1989. 138p. (AFIT/GCS/ENG–89D-7). Available from NTIS, PC A07/MF A01.

The goal of this thesis was to determine a means for automating the planning section of the Air University's Theater Warfare Exercise (TWX). By delving into the areas of Artificial Intelligence and Database Management Systems, this thesis presents a flexible, efficient, and effective platform for realizing the above goal. This thesis presents the requirements, analysis, and solutions for the realization of an automated red player for TWX. The Theater War Exercise (TWX) is a five day, two sided, theater level, air-power employment decision making exercise. The decisions required are typical of those that an air component commander and staff would make. TWX is a two-sided game where the blue team is played by a student seminar and the red team is played by one or more dedicated Air Force Wargaming Center personnel who attempt to provide a realistic red opponent. Personnel at the Air Force Wargaming Center determined that too much time was required for a red player to render an effective game. It was determined that an integration of artificial intelligence and relational database management systems would provide a flexible, innovative, and cost-effective approach for automation. An object-oriented approach was used to determine the necessary structures for automating the planning section of TWX. This included the replacement of nuclear strike aircraft, the beddown of aircraft from an augmentation base, and the resolution of logistic shortfalls at each airbase due to attrition and movement of aircraft.

24341 (LA–11774-MS) **Role of free-electron lasers in strategic defense.** Canavan, G.H. Los Alamos National Lab., NM (USA). Mar 1990. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE90008028. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Directed-energy defenses could provide the performance, growth, and cost essential for effectiveness against progressively larger and more competent threats. Because they are less sensitive to modernization rates and can grow in performance, directed-energy defenses could provide significant margin against uncertain costs and improve the effectiveness of combined defenses by factors of 2 to 3. Delays in development could cause much larger cost growths. Thus, directed-energy, generally, and free-electron lasers, specifically, are critical in bounding the threat throughout the transition. 16 refs., 8 figs.

24342 (LA–11782-MS) **SDI [Strategic Defense Initiative]: Is its future past?.** Canavan, G.H. Los Alamos National Lab., NM (USA). Mar 1990. 23p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE90008016. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper reviews likely threats and the ability of known defenses to address them, concluding that initial deployments should be affordable and development appears to be a prudent hedge against an uncertain future. Effective defenses would provide a positive incentive for the reduction of offensive forces and hence a direct, stabilizing influence that could shift the threat in directions in which they could be more effective and mutually useful. 32 refs.

24343 (ORNL/OMIS–90/3) **Optics MODIL [Manufacturing Operations Development and Integration Laboratory] Information System general operating guide.** Marchbanks, M.F. Oak Ridge National Lab., TN (USA). Jan 1990. 87p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008710. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This document, the Optics MODIL Information System (OMIS) General Operating Guide as an aid to those involved in documenting the information generated by the Survivable Optics Manufacturing, Operation, Development, and Integration Laboratory (Optics MODIL) Program of the Strategic Defense Initiative Organization (SDIO). It provides an overview of the policies and procedures of the OMIS, including the Optics MODIL Database and Optics MODIL Handbook projects, and gives guidelines to assist the participants at all working levels. The document is updated as needed to convey new or revised program policies and procedures. 10 figs.

24344 (SAND–89-2534) **Implementation of midcourse tracking and correlation on massively parallel computers: Accomplishments for fiscal year 1989.** Halbgewachs, R.D.; Tomkins, J.L.; VanDyke, J.P. Sandia National Labs., Albuquerque, NM (USA). Jan 1990. 27p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90008166. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Sandia National Laboratories joined with two other laboratories, Los Alamos National Laboratory and Naval Research Laboratory, to study and implement a highly parallelized tracker/correlator algorithm. Significant progress was made at Sandia on a specific algorithm and code. This report summarizes the accomplishments by Sandia during FY '89 on this project. 12 refs., 4 figs., 2 tabs.

4506 Chemical and Biological

24345 (AD-A–215527/3/XAB) **Physiological evaluation of men wearing three different toxicological protective systems.** Levine, L.; Cadarette, B.S.; Sawka, M.N.; Pandolf, K.B. Army Research Inst. of Environmental Medicine, Natick, MA (USA). Aug 1989. 12p. Available from NTIS, PC A03/MF A01.

This study examined the physiological responses of seven volunteers exercising in the heat while wearing three different toxicological protective systems. The Toxicological Agent Protective (TAP) suit has been available for use for more than 30 years while the other two protective systems are developmental efforts. The Self-Contained Toxicological Environmental Protection Outfit (STEPO) includes either a backpack-rebreather (with CO_2 scrubber) and ice-cooling vest (STEPO-R), or a tether system which

supplies breathing/cooling air inside the suit (STEPO-T). After the volunteers were heat acclimated, the three toxicological protection systems were evaluated utilizing a counter-balanced experimental design initially in a hot and then in a cool environment while subjects walked at 1.12 m/s, 0% grade for an attempted two hours. There was no statistical advantage of any one system in terms of exercise time in the cool environment. While evaporated sweating rate was greater for the STEPO-T in the cool environment compared to both STEPO-R and TAP. Development efforts to improve the STEPO system designs continue, and physiological evaluation of new developmental models is underway.

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Refer also to citation(s) 23831

5401 Environmental Sciences, Atmospheric

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24346 (AD-A–215331/0/XAB) **Fuel-rich solid propellant boron combustion. Final report, 1 April 1982-31 March 1983.** King, M.K.; Komar, J.; Fry, R.S. Atlantic Research Corp., Alexandria, VA (USA). 31 May 1983. 14p. (ARC–41-5032-2). Available from NTIS, PC A03/MF A01.

A unified single boron particle ignition/combustion/extinguishment model capable of treating the effects of various oxidizers, Finite-rate kinetics, and time-dependent environmental conditions has been developed and successfully checked against historical data bases. In addition, parts of this model have been combined with enthalpy and species conservation equations for analysis of boron combustion efficiency in an idealized slurry ramjet combustor (perfectly stirred reactor followed by a series of incremental plug-flow reactors with arbitrary air addition as a function of operational and design parameters). Cibsuderabke subgke particle ignition/combustion data have been obtained over a wide range of particle sizes (5-70 Microns) in wet atmospheres with this experimental effort currently being extended to dry atmospheres. An experiment to determine the kinetics of the boron oxide-water reaction (crucial to ignition) is in progress. A laboratory apparatus for studying combustion of highly-boron-loaded solid fuel ramjet grains in hot air crossflow on a fundamental basis has been completed. Design of a well-stirred reactor for study of boron cloud and slurry combustion is complete and equipment fabrication is underway.

24347 (AD-A–215493/8/XAB) **Soot formation in diffusion flames of fuel/oxygen mixtures.** Hura, H.S.; Glassman, I. Princeton Univ., NJ (USA). Dept. of Mechanical and Aerospace Engineering. 1989. 10p. Available from NTIS, PC A02/MF A01.

Pub. in International Symposium on Combustion (22nd), 371-378(1988).

Soothing trends have been measured as a function of equivalence ratio of fuel/oxygen mixtures over the range of infinity (pure diffusion flames) to low values (double flames; an inner premixed flame and an outer diffusion flame combination). All interesting observations have been explained on the basis of changes due to oxygen addition in the fuel pyrolysis chemistry, flame structure, and interaction of double flames. This effect of oxygen addition to the fuel on soot formation has been studied in coflcw and counterflow diffusion flames of ethene and propane by performing smoke height, laser light extinction, temperature, and velocity measurements.

24348 (AD-A–215633/9/XAB) **Substitution of IVD (Ion vapor deposition) aluminum for cadmium. Final report, February 1988-January 1989.** Holmes, V.L.; Muehlberger, D.E.; Reilly, J.J. EG and G Idaho, Inc., Idaho Falls, ID (USA). Aug 1989. 201p. Available from NTIS, PC A10/MF A02.

USAF is concerned about the use of toxic processing at the Air Logistics Centers (ALCs). To reduce hazardous waste generation from cadmium electroplating, McDonnell Aircraft Division (MCAIR) of McDonnell Douglas, through EG&g Idaho, was requested to determine the feasibility of substituting ion vapor deposition (IVD) of aluminum, across the board, for cadmium electroplating processes. The IVD aluminum coating and process does not generate hazardous wastes. The current phase of this contract required technical, environmental, and economical comparisons between IVD of aluminum and cadmium electroplating. This report provides that information. Recommended research and development to be conducted in Phase II of the contract is also included.

24349 (BNL–52227) **Source attribution for tropospheric ozone in the US.** Benkovitz, C.M.; Kleinman, L.I. Brookhaven National Lab., Upton, NY (USA). Jan 1990. 150p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. Order Number DE90007994. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

A methodology has been developed that allows fast evaluation of the relative contributions of different emission sectors to the production of tropospheric O_3; it can be used to evaluate numerous emissions control strategies. Regional scale hydrocarbon and ozone concentrations are calculated using a trajectory model with a linear description of hydrocarbon oxidation. Emitted hydrocarbons are assumed to react under the influence of an externally specified chemical environment. Emitted compounds are oxidized forming peroxy radicals which can oxidize NO, combine to form peroxides, or form adducts such as PAN. Secondary compounds can react further until complete oxidation occurs. Formation of O_3 is associated with NO to NO_2 conversions. The linearity of the governing equations allows calculated hydrocarbon and O_3 concentrations to be attributed to specific source regions, precursor compounds, or industrial categories. Anthropogenic and biogenic emission inventories for the contiguous US are used to calculate O_3 and hydrocarbon concentrations for a summer month, both at the national and the regional levels. 10 refs., 18 figs., 80 tabs.

24350 (BNL–52231) **^{14}C release from failed spent fuel containers: Progress report, May–September, 1989.** Pescatore, C. Brookhaven National Lab., Upton, NY (USA). [1989]. 11p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC02-76CH00016. Order Number DE90008153. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Partially failed containers may provide a meaningful barrier to the release of gaseous $^{14}CO_2$. A modeling approach is outlined and sample calculations are provided that show the effect on release due to a limited perforation area, to decreasing temperature, and to partial occlusion of the perforated area by corrosion products. 5 refs., 4 tabs.

24351 (CONF-900255–1) **Formulating energy policies related to fossil fuel use: Critical uncertainties in the global carbon cycle.** Post, W.M.; Dale, V.H.; DeAngelis, D.L.; Mann, L.K.; Mulholland, P.J.; O'Neill, R.V.; Peng, T.-H.; Farrell, M.P. Oak Ridge National Lab., TN (USA). [1990]. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Southeast regional climate symposium: global change - a southern perspective; Charleston, SC (USA); 19-22 Feb 1990. Order Number DE90008741. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The global carbon cycle is the dynamic interaction among the earth's carbon sources and sinks. Four reservoirs can be identified, including the atmosphere, terrestrial biosphere, oceans, and sediments. Atmospheric CO_2 concentration is determined by characteristics of carbon fluxes among major reservoirs of the global carbon cycle. The objective of this paper is to document the knowns, and unknowns and uncertainties associated with key questions that if answered will increase the understanding of the portion of past, present, and future atmospheric CO_2 attributable to fossil fuel burning. Documented atmospheric increases in CO_2 levels are thought to result primarily from fossil fuel use and, perhaps, deforestation. However, the observed atmospheric CO_2 increase is less than expected from current understanding of the global carbon

cycle because of poorly understood interactions among the major carbon reservoirs. 87 refs.

24352 (DMU-LUFT-A–129) **Modelling pollution from traffic in a street canyon: Evaluation of data and model development.** Hertel, O.; Berkowicz, R. Danmarks Miljoeundersoegelse, Roskilde (Denmark). May 1989. 77p. Order Number DE90760224. Available from NTIS (US Sales Only), PC A05/MF A01.

An evaluation of data from traffic pollution measurements is presented. The relationships between the meteorological dispersion conditions and the street configuration are emphasized. Measurements of NOx are used, as it can be considered a non-reactive pollution component. The results from the STREET-model are compared with the presented measurements. Subsequently a new dispersion model has been developed and evaluated. The new model accounts for local meteorological conditions and street geometry. (BN) 15 refs.

24353 (DOE/ER/60394–2) **The molecular biology of environmental aromatic hydrocarbons: Final progress report for the period January 1, 1985–December 31, 1989.** Weiss, S.B. Illinois Univ., Chicago, IL (USA). Dec 1989. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER60394. Order Number DE90009162. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The induction of mutations in living cells by polycyclic aromatic hydrocarbons (PAH) has been recognized for many years. Although the mechanism for this occurrence has been examined by numerous investigators, the precise nature and type of mutations induced is still unclear. Earlier investigations of DNA damage and repair were primarily examined by the random alkylation of bacterial and mammalian DNAs, in vivo, using a variety of different PAH agents. This procedure is still used today. Though informative, such studies have not offered any explanation of the mechanism by which PAH agents induce carcinogenesis. We have attempted to examine the repair of PAH-damaged DNA using small DNA oligomer constructs as targets for site-specific alkylation. DNA constructs containing a single BPDE alkylated site in each duplex strand were ligated into M13 RF DNA and used to transfect E. coli. Progeny M13 DNA was isolated from E. coli colonies grown on agar plates containing IPTG and Xgal. DNA sequence analysis of the isolated progeny M13 DNA, at the site of construct insertion, was found to contain large deletions and illegitimate recombinants. These sequence rearrangements occurred in either $recA^+$ or $recA^-$ host cells suggesting that SOS processing was not involved in the deletions and the recombinants observed. The mechanism by which BPDE induces illegitimate recombinants has not been resolved, however, it is possible that the closely spaced adducts activate the recombinant machinery in our DNA-damaged cells. 1 ref., 6 figs., 1 tab.

24354 (DOE/ER/60446–T1) **Technology transfer support services to the Carbon Dioxide Research Division, US Department of Energy: Final report.** Walcoff and Associates, Inc., Alexandria, VA (USA). 13 Jan 1990. 32p. Sponsored by U.S. DOE Energy Research. DOE Contract AC01-86ER60446. Order Number DE90008801. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The US Department of Energy (DOE) serves as the lead Federal agency with respect to atmospheric carbon dioxide (CO_2) and the "greenhouse effect." Within DOE, the Carbon Dioxide Research Division (CDRD) has been responsible for leading the research effort investigating atmospheric CO_2, global warming, and other aspects of the greenhouse effect. Critical to CDRD's endeavors is accurate, effective communication of research findings – not only to scientists, but to policymakers and the general public as well. The past three-and-a-half years, Walcoff & Associates, Inc., (Walcoff) has supported CDRD in meeting this technology transfer challenge. Walcoff has drawn upon a wide range of technical and professional skills to support the CDRD in its technology transfer services. Underlying all tasks has been the need to communicate highly complex, information across scientific, political and economic disciplines. During the three and a half year contract period, Walcoff has successfully provided support to the CDRD to enhance its technology transfer resources and accomplishments. 5 figs., 1 tab.

24355 (IAEA-TECDOC–502, pp. 129-142) **Isotopic variation of rains and origin of the air masses in the Chilean Altiplano.** Aravena, R. (Comision Chilena de Energia Nuclear, Santiago (Chile)); Suzuki, O.; Pena, H.; Grilli, A.; Mordeckai, M. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

This paper discusses isotopic composition of rains collected along the Cordillera del Medio and the Chilean Altiplano. This discussion is complemented with a meteorological study relating to the origin of the air masses that generate rain in northern Chile. The isotopic and meteorological evidences showed that the isotopic stratification observed in summer rains is not related to an altitude effect, but seems to be linked to the location of the convective centers that generate these rain storms. The different isotopic evolution observed between the summer and winter rains is related to the type of storms, being convective in nature during the summer and of frontal origin in the winter time. The meteorological study for the 1984 storm events showed that the source of the air masses is the Atlantic ocean via Amazonas basin. (author). 17 refs, 8 figs, 2 tabs.

24356 (IAEA-TECDOC–502, pp. 355-363) **Isotope studies of precipitation and groundwater in the Sierra de las Cruces, Mexico.** Cortes, A. (Universidad Nacional Autonoma de Mexico, Mexico City (Mexico). Inst. de Geofisica); Farvolden, R.N. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

An environmental isotope study was carried out on water samples collected from springs, streams, wells and precipitation events in the upper part of the Sierra de las Cruces mountains range in Mexico. These mountains form the western flank of the Valley of Mexico where Mexico City is located and may be an important area of recharge for the aquifers which supply a large portion of the drinking water supply of the city. A local meteoric water line is constructed from the precipitation data by a linear regression technique and is described by $\delta D = 7.95\ \delta^{18}O + 11.77$. An important feature of this data is the widespread observed in isotope values throughout the sampling season. These values range from -153 per mille to -9 per mille for Deuterium and between -20.9 per mille to -3.1 for Oxygen-18. This wide isotope range cannot be attributed to an altitude effect because all samples were collected practically on the same elevation. The history of the air masses that generate each precipitation event and variable climatic conditions at the site could be responsible for this effect. Groundwater samples obtained from springs, streams and wells do not show the same ranges of variation as precipitation; most of them are close to the average precipitation values: $\delta D = -70$ per mille and $\delta^{18}O = -10.3$ per mille. This value can be considered representative of the isotopic composition of the water that may recharge the Valley of Mexico aquifer system in the Sierra de las Cruces area. (author). 14 refs, 3 figs, 2 tabs.

24357 (INIS-mf–11570) **Nuclear power and the carbon dioxide problem: A study executed with financial aid of the Ministry of housing, planning and environmental control.** Bijlsma, J.J.; Blok, K.; Turkenburg, W.C. Rijksuniversiteit

Utrecht-Ministerie VROM Collaboration. Rijksuniversiteit Utrecht (Netherlands). Vakgroep Natuurwetenschap en Samenleving. May 1989. 55p. (In Dutch). Order Number DE90706068. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

This study deals with the question, which contribution can be delivered by nuclear power to the reduction of the emission of carbon dioxid (CO^2) from the power supply. The emphasis lays upon the following aspects: the emissions of CO^2 which occur in the nuclear-power cycle (the so-called indirect emission of CO^2 power plants); the amount of uranium stocks; the change of CO^2 emission cause by replacement of fossil fuels, in particular coal, by nuclear power. First an energy-analysis of the nuclear power cycle is presented. On the base of this analysis the CO^2 uranium can be calculated. The role of nuclear power in the reduction of CO^2 emission depends on the development of the final power demand. Therefore in this study two scenarios derived from the 'IIASA-low' scenario; 'low-energy'-scenario in which the world-energy consumption remains at about the same level. In the calculations the indirect emissions of CO^2, also dependent on the ore richness and the technology used, have always been taken into account. In the calculations two uranium-reserve variants of resp. 5.7 and 30 mln. tons have been assumed. From the results of the calculations it can be concluded that whether or not taking account of the indirect emissions of CO^2 in the nuclear power cycle, has only limited effect on the calculated contribution of nuclear power to the solution of the greenhouse effect. The uranium reserves turn out to be determining for the potential contribution of nuclear power. By putting on the surely available reserve of 5.7 mln. tons, or the speculative reserve of 30 mln. tons, with the actual technology, an emission of resp. 130-140 billion and 880 billion tons CO^2 can be avoided in replacing coal. With maximal employment of improved conversion techniques these contributions may be doubled. (H.W.). 40 refs.; 13 figs.; 10 tabs.

24358 (NEI-DK–264, pp. 231-242) **Numerical modeling of local atmospheric flow and air pollution dispersion in coastal areas of the Baltic Sea.** Uliasz, M. (Institute of Environmental Engineering, Technical University of Warsaw, Warsaw (PL)). Technical Univ. of Denmark, Lyngby (Denmark). Inst. of Mathematical and Operations Research. 1989. (CONF-8809459–: Conference on the systems analysis approach to environmental and natural resources management in the Baltic region, Gdansk (Poland), 26-29 Sep 1988). In *Proceedings of the conference on the systems analysis approach to environmental and natural resources management in the Baltic region.* Order Number DE90760200. Available from NTIS (US Sales Only), PC A13/MF A01.

The mesoscale dispersion modeling system is under development with the purpose of investigating atmospheric flow and air pollution dispersion in coastal zones of the Baltic Sea. An example of numerical simulation of air pollution dispersion in the vicinity of the Zarnowiec nuclear power plant in northern Poland is presented. The mesoscale model is evaluated against measurement data from the Oeresund experiment. (author).

24359 (NEI-DK–264, pp. 243-255) **Emissions of SO_2, NO_x and CO_2 from the Danish energy sector in the period 1975-2010.** Fenhann, J. (Systems Analysis Department, Risoe National Laboratory, Roskilde (DK)); Halsnaes, K. Technical Univ. of Denmark, Lyngby (Denmark). Inst. of Mathematical and Operations Research. 1989. (CONF-8809459–: Conference on the systems analysis approach to environmental and natural resources management in the Baltic region, Gdansk (Poland), 26-29 Sep 1988). In *Proceedings of the conference on the systems analysis approach to environmental and natural resources management in the Baltic region.* Order Number DE90760200. Available from NTIS (US Sales Only), PC A13/MF A01.

Emissions of SO_2, NO_x and CO_2 are calculated for each category of the Danish primary energy consumption. The calculations are made for the period 1975-2010, based on statistics for the historical period and the most recent energy demand forecast from the Danish Ministry of Energy. The Danish regulations for reduction of SO_2 and NO_x emissions are mentioned together with the options for reducing the CO_2 emissions. (author).

24360 (NEI-DK–266) **SO2, NOx and CO2 emissions from the total Danish energy systems: 1975-1988.** Fenhann, J. Risoe National Lab., Roskilde (Denmark). Systems Analysis. Sep 1989. 46p. (In Danish). Order Number DE90760215. Available from NTIS (US Sales Only), PC A03/MF A01.

A collection of tables illustrating the emission of SO2, NOx and CO2 from the total Danish energy system during the period 1975-88. The emission occurrence is divided up according to sectors (eg power plants, industrial processes etc), and, following, according to fuel types. A prognosis reaching to year 2010 is also prestened. (AB).

24361 (NEI-DK–286) **Modeling and chemical reactions: Review of turbulence and combustion models.** Lilleheie, N.I. (SINTEF / The Norwegian Institute of Technology, Division of Thermodynamics (Denmark)); Ertesvaag, I.; Bjoerge, T.; Byggstoeyl, S; Magnussen, B.F. Nordisk Gasteknisk Center, Hoersholm (Denmark). Jul 1989. 67p. Order Number DE90760249. Available from NTIS (US Sales Only), PC A04/MF A01.

Various aspects of the modeling of natural gas combustion in technical environment, with special emphasis on pollutant formation, are discussed. Turbulent reacting flow describes the mechanism of eddy formation and dissipation, and mathematical treatment depends on the applied coordinate system, Lagrangian or Eulerian. The Eulerian approach, calls for a statistical treatment of the turbulence, as well as for the interaction between the turbulence and the chemical reactions. These models have to be calibrated against experimental data. The fundamental equations describing reacting flows are presented, and it is shown how the physical submodels enter into the governing equations. A review of turbulence models, from the simple algebraic models to the more elaborate Reynolds-stress models, concludes that the socalled k - epsilon model can be applied to turbulent flows with moderate complexity, while a Reynolds-stress model must be used for more complicated flows. Wall influence can be dealt with by wall function methods, but, emphasis should be put on further development of the "Eddy Dissipation" turbulence model which involves wall-turbulence interactions as well as low Reynolds-number effects. The review recommends the "Eddy dissipation concept" as being well suited for inclusion of chemical kinetics while at the same time favourable for the computation of mixing controlled combustion. It can be used for prediction of natural gas combustiõn. (AB) 61 refs.

24362 (NEI-DK–287) **Reburning: Status of international experience.** Glarborg, P. (Laboratoriet for Varme- og Klimateknik, Danmarks Tekniske Hoejskole (Denmark)); Hadvig, S. Nordisk Gasteknisk Center, Hoersholm (Denmark). Jul 1989. 58p. (In Danish). Order Number DE90760250. Available from NTIS (US Sales Only), PC A04/MF A01.

A survey of the international experiences of reburning. Reburning is an NOx control method that removes NOx from the combustion effluents using fuel as reducing agent. Based on kinetic calculations and selected data from flow reactor and pilot scale experiments the report analyzes the chemistry of the reburning process using different reburning fuels. From pilot scale results in the literature the importance of the various process parameters are discussed and guidelines for optimum performance using natural gas and coal, respectively, as reburning fuels are outlined. The different practical reburning fuels are compared and it is shown that natural gas is advantageous as reburning fuel since it is more efficient and requires less residence time. In order to achieve the best performance using natural gas as reburning fuel the following rules should followed: Optimum excess air ratio in the primary combustion zone should be 1.05-1.1. Allow for complete burn out of the primary fuel before adding the reburning fuel (with coal as primary fuel a residence time of at least 300 msec is required in the primary zone). Optimize gas injection to achieve rapid mixing. Maximize the temperature at the reburning fuel injection point. Allow a residence time in the reburning zone of 400 msek. At low NO-levels a shorter residence time may be adequate. Under most conditions the optimum amount of reburning fuel is 15-20%, corresponding to an excess air ratio of 0.9. However, if the reburning temperature is relatively low (<=1400K) efficiency can be improved by raising the amount of reburning fuel. A short discussion of full scale tests that have been carried out in Japan and United States is presented. (AB) 22 refs.

24363 (NILU-F-9/89) **European inventory of trace metal emissions to the atmosphere.** Pacyna, J.M.; Munch, J. Norsk Inst. for Luftforskning, Lillestroem (Norway). May 1989. 5p. (CONF-890975–4: 7. international conference on heavy metals in the environment, Geneva (Switzerland), 12-15 Sep 1989). Order Number DE90760257. Available from NTIS (US Sales Only), PC A02/MF A01.

Estimates of atmospheric emissions of As, Cd, Hg, Pb, and Zn from major anthropogenic sources are presented on the basis of emission factors and statistical data. Individual emission factors were used for major non-ferrous metal smelters and coal-, and oil-fired power plants in Europe. Collective emission factors were calculated for other source categories. Total emissions were then spatially distributed within the EMEP grid of 150 km x 150 km. 3 refs., 1 fig., 3 tabs.

24364 (NILU/OR–23/89) **CO_2 and climate.** Knudsen, S. Norsk Inst. for Luftforskning, Lillestroem (Norway). Apr 1989. 24p. (In Norwegian). Order Number DE90760258. Available from NTIS (US Sales Only), PC A03/MF A01.

The temperature will most likely rise with rising concentrations of greenhouse gases in the atmosphere. By doubling the CO_2 concentration, prognoses predict a rise in temperature of approximately 1.5-4.5^{o}C. The other greenhouse gases contribute to this temperature rise as well. A 200 MW gas power plant will contribute to CO_2 emissions from industrial combustion with approximately 7%. 22 refs., 5 figs., 3 tabs.

24365 (NILU/OR–48/89) **Emissions of major air pollutants emitted in Eastern Europe.** Pacyna, J.M. Norsk Inst. for Luftforskning, Lillestroem (Norway). Sep 1989. 54p. Order Number DE90760259. Available from NTIS (US Sales Only), PC A04/MF A01.

The report presents estimates of the 1982 emissions of SO_2, NO_x, volatide organic compounds (VOC), NH_3, CH_4, CO and N_2O from sources in Eastern Europe. These estimates will be used in the work with a European scale transport, transformation and deposition model for atmospheric constituents within the European Modeling of Atmospheric Constituents (EMAC) program. 26 refs., 12 figs., 42 tabs.

24366 (ORNL/TM–11457) **Report of a workshop on climate feedbacks and the role of peatlands, tundra, and boreal ecosystems in the global carbon cycle.** Post, W.M. (ed.). Oak Ridge National Lab., TN (USA). Feb 1990. 37p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. (CONF-8804321–Summ.: Workshop on climate feedbacks and the role of peatlands, tundra, and boreal ecosystems in the global carbon cycle, Oak Ridge, TN (USA), 4-6 Apr 1988). Order Number DE90008081. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Environmental Sciences Division Publication No. 3289.

A workshop held in Oak Ridge, Tennessee, assembled leading North American researchers to discuss recent research results and accomplish three goals: (1) estimate, given current knowledge, the net flux of carbon cycle gases between northern ecosystems and the atmosphere under projected climates for atmospheric CO_2 concentrations approaching 580 ppmv; (2) determine the key uncertainties in such a calculation and the short-term research necessary to significantly reduce these uncertainties; and (3) identify long-term research objectives that will increase our confidence in the accuracy of carbon cycle gas flux estimates in northern ecosystems. The research summaries included studies to (1) understand the relationships between climate, direct effects of increased CO_2, nutrient cycling and organic matter production and accumulation in peatland, tundra, and boreal ecosystems; and (2) extend current experimental methods of using remote sensing for the difficult task of extrapolating stand or subsystem processes over regional or global scales. 169 refs., 4 figs., 2 tabs.

24367 (PB–90-132432/XAB) **Meteorological influences on mountain cloudwater chemistry in the eastern USA.** Vong, R.J.; Bailey, B.H.; Markus, M.J.; Mohnen, V.A. Oregon State Univ., Corvallis, OR (USA). Dept. of Atmospheric Science. 1989. 6p. Available from NTIS, PC A02/MF A01.

To relate cloudwater composition with large-scale circulation features, cloud events sampled during the 1986-88 field seasons by the U.S. EPA Mountain Cloudwater Chemistry Pragram (MCCP) were classified according to the principal synoptic features responsible for cloud production. The scheme classifies cloud events according to a mountain's location relative to surface weather map features for hours when cloud was observed at the sites. Goals were to: (1) understand the extreme variability in cloud water chemistry; (2) analyze the effect of the part-time, non-random sampling protocol (every cloud hour was sampled during several multiple week sampling intensives but no events were sampled for other multiple week periods); and (3) establish meteorological scenarios for cloud water interception models.

24368 (PB–90-132440/XAB) **Use of forest site index for evaluating terrestrial resources at risk from acidic deposition.** Loucks, O.L. Institute of Ecology, Indianapolis, IN (USA). c 1989. 17p. Available from NTIS, PC A03/MF A01.

Pub. in Direct and Indirect Effects of Acid Deposition on Vegetation, Chapter 8, Vol. 5, 97-109(1984).

The principal goal of the chapter is a discussion of the applicability of forest growth measurement to the detection of acidic deposition impacts on forest growth. The chapter has grown out of studies undertaken for EPA on the quantification of linked land and water system responses in watersheds following addition of acidic deposition, with an emphasis on integrative measures of terrestrial and aquatic effects in the same watershed.

24369 (PB–90-134164/XAB) **Demonstration of autonomous air monitoring through robotics.** Rancatore, R. Little (Arthur D.), Inc., Cambridge, MA (USA). Nov 1989. 55p. Available from NTIS, PC A04/MF A01.

The project included modifying an existing teleoperated robot to include autonomous navigation, large object avoidance, and air monitoring and demonstrating that prototype robot system in indoor and outdoor environments. The robot was also modified to carry a HNU PI-101 Photoionization Detector air monitoring device. A sonar range finder, which already was an integral part of the Surveyor, was repositioned to the front of the robot chassis to detect large obstacles in the path of the robot. In addition, the software of the onboard computer was also extensively modified to provide: navigation control, dynamic steering to smoothly follow the wire-course without hesitation, obstacle avoidance, autonomous shut down and remote reporting of toxic substance detection.

24370 (PB–90-134172/XAB) **Follow-up alpha-track monitoring in 40 eastern Pennsylvania houses with indoor radon-reduction systems. (Winter 1988-89). Final report, December 1988-June 1989.** Scott, A.G.; Robertson, A. American ATCON, Inc., Wilmington, DE (USA). Oct 1989. 27p. Available from NTIS, PC A03/MF A01.

The report gives results of 4-month-long alpha-track detector (ATD) measurements of indoor radon concentrations, completed during the winter of 1988-89 in 38 of 40 houses where radon reduction techniques had been installed 2-4 years previously during an earlier EPA project. The techniques, installed between June 1985 and June 1987, generally involved some form of active soil ventilation: three were air-to-air heat exchangers, and two involved carbon filters to remove radon from well water. The purpose of these measurements was to determine if the radon reduction performance of the systems had degraded compared to previous wintertime radon measurements. Comparison of the current ATD results with those from 1986-87 and 1987-88 indicates that, in the 34 houses where the system was in continuous operation during this measurement period, the radon levels generally compared well with those measured during the previous years. In only two houses did significant, unexplainable increases occur. Two soil ventilation fans failed during the previous year: 5 out of 34 fans have failed to date. One air-to-air heat exchanger has needed repair. The one water treatment unit designed specifically for radon removal is giving 97% removal, whereas the other has degraded to 65%.

24371 (PB–90-134297/XAB) **Environmental Research Laboratory-Corvallis. Draft report.** Lackey, R.T. Environmental Protection Agency, Corvallis, OR (USA). Environmental Research

Lab. 21 Apr 1989. 13p. (EPA–600/D-89/222). Available from NTIS, PC A03/MF A01.

Laboratory research programs address several broad areas, including the ecological effects of airborne pollutants, such as ozone, acid rain, and air toxics; the effects of toxic chemicals on plants, animals, and ecosystems; the assessment and restoration of contaminated or degraded environments; the characterization and assessment of the vulnerability of ecological systems, such as wetlands, to human impacts; the use of aquatic ecoregions to develop biological criteria for assessing aquatic ecosystems; the ecological risks from the terrestrial release of bioengineered organisms and other biological control agents; and the ecological effects of global climate change, stratospheric ozone depletion, and loss of biological diversity.

24372 (PB–90-135278/XAB) **Present and future EPA (Environmental Protection Agency) incineration research facility.** Richards, M.K. Environmental Protection Agency, Cincinnati, OH (USA). Risk Reduction Engineering Lab. c 1989. 6p. (EPA–600/J-89/241). Available from NTIS, PC A02/MF A01.

Pub. in Jnl. of the Air Pollution Control Association, Vol. 39, No. 10, 1309-1312(Oct 1989).

The Hazardous and Solid Waste Amendments (HSWA) of 1984 require treatment of specified industrial and hazardous wastes before they can be landfilled. Incineration has been proposed as a solution to the disposal problem of some of these wastes. Since not all wastes can be safely incinerated; parametric factors determine the effectiveness of incineration destruction of toxic materials is necessary. The Environmental Protection Agency operates an experimental facility in Jefferson, Arkansas, which, among other functions, evaluates thermal treatment for hazardous wastes. The paper discusses the studies that have been carried on at the CRF and the potential for the hazardous waste community to use the physical plant which essentially quadrupled its size. It is now possible for the EPA's Risk Reduction Engineering Laboratory (RREL) to accommodate 3rd-Party users at the Arkansas plant; related information is presented.

24373 (PB–90-136144/XAB) **Health assessment for Nyanza Chemical Dump, Ashland, Massachusetts, Region 1. CERCLIS No. MAD990685422. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 12 May 1983. 7p. Available from NTIS, PC A02/MF A01.

The data submitted for the Nyanza Chemical Dump site is limited to a single sampling trip. Samples were collected from four stations on, or in the vicinity of the site, for mercury and other air pollutants, as well as soil (or sludge) samples. The ambient air temperature was 15 to 20 degrees Farenheit at the time of collection. The concentration of pollutants detected in the air during the cold weather sampling at the site do not constitute a health hazard. Warm weather samples should be collected from the site. The site has levels of mercury in the soil which are of concern as they are considerably above natural soil levels. The source of the organic compounds at the site should be determined.

24374 (PB–90-142217/XAB) **Aerosol separator for use in aircraft. Technical memo.** Boatman, J.F.; Wellman, D.L.; Keene, W.D.; Galloway, J.N. National Oceanic and Atmospheric Administration, Silver Spring, MD (USA). Air Resources Lab. Dec 1989. 26p. (NOAA-TM-ERL-ARL–179). Available from NTIS, PC A03/MF A01.

When sampling atmospheric aerosols using aircraft, it is sometimes advantageous to separate a portion of the aerosol from the sample stream. During flights through clouds, one may wish to separate all cloud water from the air stream so that interstitial aerosol particles and gases can be measured. Alternately, when flying within the marine boundary layer, one may wish to separate large sea-salt particles from the air stream in order to increase resolution in the calculation of non-sea-salt constituents. The goal of the work was to build and test an aerosol separator. To achieve this goal, a separator was developed, tested in the laboratory and during flights aboard the National Oceanic and Atmospheric Administration King Air research aircraft. The paper summarizes the results of the effort.

24375 (PB–90-142548/XAB) **Across North America Tracer Experiment (ANATEX). Volume 2. Aircraft-based sampling. Technical memo.** Stunder, B.J.B.; Draxler, R.R. National Oceanic and Atmospheric Administration, Silver Spring, MD (USA). Air Resources Lab. Oct 1989. 67p. (NOAA-TM-ERL-ARL–177). Available from NTIS, PC A04/MF A01.

See also PB–89-156137.

Aircraft-based sampling was an integral part of ANATEX. The data are useful for establishing the initial tracer path and for providing vertical tracer distributions. Because there were few, if any, ground-level sampling sites near the sources, the aircraft sampling was done within about 450 km of the two release sites (Glasgow, MT (GGW) and St. Cloud, MN (STC)) and between altitudes near the ground to 2800 m above ground. One or two aircraft sampled 26 of the 33 GGW plumes. Usually one flew above the other to obtain vertical tracer profiles. The GGW plume was traversed at least once for 23 of the 26 releases sampled, with 30% of all the samples near GGW containing excess tracer. One aircraft sampled 16 STC plumes, with tracer concentrations above background reported for all 16 releases. Fifty percent of all the samples of the STC plume contained excess tracer. The instrumentation, operations, and data quality assurance are discussed. The complete archived dataset, consisting of aircraft position data, tracer data, and meteorological data, is included in the report. In addition, data summaries for all flights are displayed in a tabular format.

24376 (PB–90-143918/XAB) **Health assessment for Artel Chemical Company, Formerly Fike Chemical, Incorporated, City of Nitro, Putnam and Kanawha Counties, West Virginia, Region 3. CERCLIS No. WVD047989207. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 23 Sep 1988. 11p. Available from NTIS, PC A03/MF A01.

The Artel Chemical Company site, formerly known as Fike Chemical Inc., manufactured specialty chemicals. There are many compounds on-site which are known to represent imminent and significant public health threats. Several compounds/contaminants of the most immediate concern are methyl mercaptan, bromine, sodium, ethyl and sodium fluoroacetate, and cyanide compounds. ATSDR has concluded that this site is of urgent public health concern because of the risk to human health resulting from the potential exposure to hazardous substances at concentrations that may result in acute health effects or death.

24377 (PB–90-144122/XAB) **Health assessment for Lansdowne Radiation, Lansdowne, Pennsylvania, Region 3. CERCLIS No. PAD980830921. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 11 Oct 1985. 10p. Available from NTIS, PC A02/MF A01.

Portions of this document are not fully legible.

The Agency for Toxic Substances and Disease Registry was asked to provide advice and guidance on the steps that should be taken to determine which personal items contaminated with radium-226 can be retained for personal use by the owner of the residence at 186 Lansdowne Ave in Lansdowne, Pennsylvania. They were also asked to advise on the health risks associated with the radiation levels currently present at this residence and to help determine whether further decontamination is necessary. The reported measurements of alpha, beta, and gamma radiation are all above background, and in many cases exceed guidelines used to determine remedial action. According to current radiation protection criteria, these levels pose an unacceptable health risk for residents of this house. Additional decontamination of the basement, the area above the boys bedroom on the third floor responsible for the gamma radiation exposure, and any other area found to exceed exposure guidelines in subsequent surveys is recommended.

24378 (PB–90-144478/XAB) **Health assessment for Dixie Caverns Landfill, Salem, Virginia, Region 3. CERCLIS No. VAD980552095. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 20 Jan 1988. 8p. Available from NTIS, PC A02/MF A01.

The Dixie Caverns Landfill, located in Salem, Virginia, is a 27-acre former municipal and light industrial sanitary landfill, consisting of a fly ash pile, organic sludge pit, and drum storage area. It operated from 1955 to 1976. Contamination on-site consists of lead

and cadmium; and bis(2-chloroethoxy)methane, nitrobenzene, di-n-octylphthalate, naphthalene, 2,4-dichlorophenol, pentachlorophenol, 1,1-dichloroethane, benzene, diethylphthalate, di-n-butylphthalate, and bis(2-ethylhexyl)phthalate. The site represents a potential public health threat. An inhalation exposure hazard exists for visitors to the site, considering the high lead concentrations present in the fly ash, a material of fine particle size. Information currently available on the extent of surface water, groundwater, and sediment contamination is not adequate to determine if a public health threat also exists from these pathways.

24379 (PB–90-857723/XAB) **Acid precipitation. September 1967-January 1990 (Citations from the COMPENDEX data base). Report for September 1967-January 1990.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 140p. Available from NTISPC N01/MF N01.

Supersedes PB–89-853816.

This bibliography contains citations concerning the causes, effects, sources, and controls of acid precipitation and acidification. Techniques and technology for measurement and analysis of acid precipitation are considered. (This updated bibliography contains 277 citations, 87 of which are new entries to the previous edition.)

24380 (PNL-SA–16909) **Use of environmental monitoring data in evaluation of atmospheric modeling results.** Droopo, J.G. Jr. Pacific Northwest Lab., Richland, WA (USA). Oct 1989. 10p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. (CONF-891053–18: 28. Hanford life sciences symposium on environmental monitoring, restoration and assessment: what have we learned?, Richland, WA (USA), 16-19 Oct 1989). Order Number DE90008607. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Modeling results are often used to conduct assessments of exposures resulting from releases to the atmosphere. Routine air monitoring has been conducted at many of the US Department of Energy's (DOE's) major facilities. In the application of the Multimedia Environmental Pollutant Assessment System (MEPAS) to DOE environmental issues as part of DOE's Environmental Survey, these monitoring data have been found to be very useful in evaluation of modeling results. An illustrative example is given of the comparison of monitoring and modeled data at DOE sites. 3 refs., 1 fig.

24381 (RFP–4409) **Terrain-Responsive Atmospheric Code (TRAC) style guide: Volume 2, Production format.** Hodgin, C.R.; Ladman, R.W. EG and G Rocky Flats, Inc., Golden, CO (USA). Feb 1990. 78p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-90DP62349. Order Number DE90008861. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This volume provides production guidelines for the documentation of the Terrain-Responsive Atmospheric Code (TRAC). This documentation is divided into five categories: promotional, technical reference, system reference, bibliography, and user documentation. This format guide has been produced for TRAC editors and production personnel, as well as for the authors of TRAC documentation, so that they may have the insight as to how their finished product will look. This is done in the hope that by visualizing the finished, or near-finished product, authors will have at their disposal the format with which to conceptualize their raw material into published documentation. In creating five basic types of TRAC documents – promotional, technical reference, system reference, bibliography and user documentation – the editors have provided TRAC authors with the tools they need to channel their technical expertise into a larger, overall effort: the complete documentation of the Terrain-Responsive Atmospheric Code. 48 figs.

24382 (S-HRG–101-377) **Consumer Ozone Protection Act of 1989.** Committee on Commerce, Science, and Transportation (U.S. Senate), Washington, DC (USA). 1989. 107p. (GPO–24-159). Available from Subcommittee on the Consumer, Senate, Washington, D.C. 20510 HC free; SOD HC $3.25 as 552-070-07449-0.

Hearings before a subcommittee of the Senate Committee on Commerce, Science, and Transportation are presented in regard to the labeling of consumer products containing substances that contribute to the depletion of the ozone layer in the upper atmosphere; regulation of the sale, distribution, and use of such substances in consumer products and services in and affecting interstate commerce; and recapture and recycling of such substances, and for other purposes.

24383 (UCRL–102793) **An intercomparison of general circulation model predictions of regional climate change.** Grotch, S.L. Lawrence Livermore National Lab., CA (USA). Nov 1989. 25p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-8909308–1: International conference on modeling of global climate change and variability, Hamburg (Germany, F.R.), Sep 1989). Order Number DE90008325. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Simulations using the best-available general circulation models (GCMs) to estimate the sensitivity of the climate to a doubling of the atmospheric carbon dioxide concentration are in broad general agreement that, at equilibrium, the global annual average surface air temperature would increase about 2–5K. Because of considerable public interest in potential climate changes due to greenhouse gases, there is pressure to use the predictions of these GCM simulations for regional climate assessments. In this work, statistical intercomparisons were made of the estimates for both the control and the equilibrium changes in surface air temperature and precipitation after a doubling of atmospheric CO_2 as predicted by five GCMs. Intercomparisons were also made with historical data for the simulations of current climate. Two data fields which are of particular importance in regional impact studies are examined here: (1) surface air temperature and (2) precipitation. The seasonally averaged results predicted by five GCMs are intercompared among models and with observational data for the control climate over different scales. Intercomparisons are also made among the models for predictions of the change at equilibrium in these two variables after a doubling of atmospheric carbon dioxide. 11 refs., 13 figs.

24384 Nitrogen oxides from high-altitude aircraft: An update of potential effects on ozone. Johnston, H.S. (Department of Chemistry, University of California, Berkeley (USA)); Kinnison, D.E.; Wuebbles, D.J. *Journal of Geophysical Research (USA)*, 94(D13): 16351-16364 (20 Nov 1989).

A sensitivity study is carried out using the Lawrence Livermore National Laboratory one-dimensional and two-dimensional chemical-radiative-transport models of the global atmosphere to examine possible effects of future aircraft NO_x emissions to stratospheric ozone. A broad range in magnitude, altitude, and latitude of the assumed NO_x emissions is examined. Major findings of this initial study are as follows: (1) Nitrogen oxides from the exhaust gases of stratospheric aircraft can reduce stratospheric ozone on a global basis. These calculated ozone reductions depend strongly on NO_x injection altitude and magnitude. (2) The altitude at which NO_x emissions cause the largest reduction in the ozone column is about 25 km according to one-dimensional model calculations and about 28 km according to the two-dimensional model. (3) For a given altitude and magnitude of NO_x emissions, the two-dimensional model finds that the reduction of global ozone depends on latitude of the injections, with maximum ozone reduction for tropical injection. For a given injection, the largest ozone column reductions occur in the polar regions. (4) For very large Cl_x mixing ratios, NO_x emissions can increase the ozone column, partially counteracting the ozone reduction caused by Cl_x. This effects found only in a highly Cl_x perturbed stratosphere where ozone is already greatly depleted. (5) Water vapour (without nitric oxide) in the exhaust gives a small ozone reduction; water vapor and nitric oxide together give an ozone reduction less than that calculated for NO alone by factors between 0.85 and 0.97.

24385 Evaluation of excess carbon 14 and strontium 90 data for suitability to test two-dimensional stratospheric models. Johnston, H. (Department of Chemistry, University of California, Berkeley (US)). *Journal of Geophysical Research (USA)*, 94(D15): 18485-18494 (20 Dec 1989).

From reports by the Atomic Energy Commission concerning the atmsopheric distribution of radionucleides following the nuclear bomb tests of 1958–1959 and 1961–1962, excess carbon 14 data from the period 1959–1970 and strontium 90 data from 1963–1967 are reviewed for possible use as inert tracers to test two-dimensional stratospheric-tropospheric models. Contrary to some views expressed in the literature, it is concluded that the carbon 14

data are suitable to test (1) the altitude (at 4 latitudes) of the transition region between troposphere and stratosphere with respect to transport of an inert tracer, (2) some aspects of transport between the northern and southern hemispheres, (3) horizontal and vertical transport as the vertical profile between 4.5 and 33 km and at 31°N evolves from a skewed Gaussian in 1963 to an almost stair-step profile in 1966, and (4) the long-term one-dimensional aspect of a two-dimensional model over the period 1966–1970. More tentatively, it is concluded that the strontium 90 data may be used as a model for the distribution and gross settling rate of the natural stratospheric aerosol layer between 15 and 25 km. Data from difficultly obtained laboratory reports and suggested initial conditions and boundary conditions are included as a microfiche supplement to this paper. © American Geophysical Union 1989

24386 **Sensitivity study of advection and diffusion coefficients in a two-dimensional strastospheric model using excess carbon 14 data.** Shia, R. (Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena (US)); Yung, Y.L.; Allen, M.; Zurek, R.W.; Crisp, D. *Journal of Geophysical Research (USA)*, 94(D15): 18467-18484 (20 Dec 1989).

Using the California Institute of Technology/Jet Propulsion Laboratory two-dimensional transport model, with transport coefficients taken from Yang and Tung (1989), we study the time evolution of excess carbon 14 in the stratosphere and the troposphere from October, 1963 to December, 1966. The model provides a satisfactory simulation of the observed data. Due to the impulsive nature of its source, initial distributions of excess carbon 14 exhibit large spatial gradients. This permits important constraints on the range of transport coefficients in the lower stratosphere to be derived. The standard model use the circulation and eddy diffusivity of the year 1980. Large deviations (by factor of 2) from this standard transport are ruled out by our model. A self-consistently derived K_{yy} which is small ($\sim 10^9$ cm^2 s^{-1}) in tropical regions, but is larger ($\sim 10^{10}$ cm^2 s^{-1}) at higher latitudes is preferred. A K_{zz} as large as 1×10^4 cm^2 s^{-1} would be inconsistent with the data. Excess carbon 14 is removed from the atmosphere with surface deposition velocities $v_S = 3 \times 10^{-3}$ cm s^{-1} and $v_N = 5 \times 10^{-3}$ cm s^{-1} in the southern and northern hemispheres, respectively. The last result is contrary to the current understanding that the oceans are the dominant sink for excess ^{14}C. © American Geophysical Union 1989

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Refer also to citation(s) 23375, 23381, 23382, 23383, 23385, 23386, 23388, 23389, 23391, 23497, 23498, 23499, 23501, 23502, 23528, 23598, 23615, 23616, 23830, 23888, 24012, 24356, 24373, 24439, 24440, 24460, 24462, 24463, 24464, 24466, 24467, 24468, 24469, 24470, 24471, 24472, 24473, 24474, 24475, 24476, 24477, 24478, 24479, 24482, 24483, 24484, 24485, 24486, 24487, 24488, 24489, 24490, 24491, 24494, 24496, 24497, 24498, 24499, 24500, 24502, 24503, 24504, 24505, 24506, 24507, 24508, 24509, 24510, 24511, 24512, 24513, 24514, 24515, 24516, 24517, 24521, 24522, 24523, 24524, 24525, 24526, 24527, 24528, 24529, 24531, 24532, 24534, 24536, 24537, 24542, 24543, 24544, 24545, 24546, 24547, 24549, 24550, 24551, 24552, 24553, 24555, 24556, 24557, 24558, 24560, 24561, 24562, 24563, 24564, 24565, 24566, 24567, 24568, 24571, 24572, 24573, 24574, 24575, 24576, 24579, 24580, 24583, 24584, 24587, 24588, 24589, 24590, 24591, 24592, 24593, 24594, 24595, 24597, 24598, 24599, 24600, 24601, 24602, 24604, 24605, 24606, 24607, 24609, 24611, 24612, 24614, 24615, 24617, 24618, 24619, 24620, 24621, 24622, 24624, 24625, 24627, 24629, 24630, 24631, 24632, 24633, 24634, 24635, 24637, 24638, 24639, 24640, 24641, 24642, 24643, 24644, 24645, 24646, 24647, 24650, 24651, 24654, 24655, 24657, 24660, 24661, 24662, 24663, 24665, 24666, 24667, 24668, 24669, 24672, 24673, 24674, 24676, 24677, 24678, 24679, 24680, 24681, 24682, 24683, 24684, 24685, 24686, 24687, 24688, 24690, 24691, 24692, 24693, 24694, 24695, 24696, 24697, 24698, 24699, 24792, 24793, 24794, 24795, 24796, 24798, 24799, 24800, 24802, 24803, 24805, 24806, 24807, 24808, 24809, 24810, 24811, 24812, 24813, 24814, 24815, 24816

24387 (AD-A-215278/3/XAB) **Hazardous-waste technical assistance survey, Altus Air Force Base, Oklahoma. Final report, 8 January-13 January 1989.** Zimmer, A.T.; Hedgecock, N.S. Air Force Occupational and Environmental Health Lab., Brooks AFB, TX (USA). Aug 1989. 58p. (AFOEHL–89-085EQ0006HHB). Available from NTIS, PC A04/MF A01.

At the request of 443 ABG/DEEV, AFOEHL personnel conducted a hazardous waste technical assistance survey at Altus AFB from 8 to 13 January 1989. The purpose of this survey was to address an Administrative Compliance Order issued by the Oklahoma State Department of Health on 26 July 1988. The scope of the survey included hazardous waste management practices, waste disposal practices, and waste minimization alternatives. The survey team performed a shop-by-shop evaluation of chemical waste management practices as well as met with hazardous waste managers and engineers to discuss the hazardous waste program. The results of our survey showed that Altus AFB has a workable hazardous waste program that needs further development.

24388 (DOE/EIS–0132-F-Vol.2) **Remedial actions at the former Union Carbide Corporation uranium mill sites, Rifle, Garfield County, Colorado: Final environmental impact statement: Volume 2, Appendices.** USDOE Albuquerque Operations Office, NM (USA). Uranium Mill Tailings Remedial Action Project Office. Mar 1990. 588p. Sponsored by U.S. DOE Nuclear Energy. Order Number DE90007912. Available from NTIS, PC A25/MF A01; OSTI; INIS.

This appendix provides the information needed to understand the conceptual designs for the remedial action alternatives addressed in this environmental impact statement (EIS). It is intended to provide sufficient details for the reader to evaluate the feasibility and assess the impacts of each remedial action alternative. It is not intended to provide the detailed engineering necessary to implement the alternatives. Details of the preferred remedial action will be presented in the remedial action plan (RAP). The remedial action alternatives addressed in this EIS include no action, stabilization at the New Rifle site, disposal at the Estes Gulch site, and disposal at the Lucas Mesa site. All alternatives include interim actions to remediate existing health and safety hazards to the Rifle community that presently exist at the Old and New Rifle processing sites. It should be noted that the borrow sites included in this EIS were selected as the sources of the necessary borrow materials for impacts analyses purposes only. The borrow sites to be used for the remedial action will be selected during the final design. 21 figs., 18 tabs.

24389 (DOE/ER/60612–3) **Processes of community development and responses of ecosystems to climate change: Progress report, September 29, 1989–September 27, 1990.** Redente, E.F. Colorado State Univ., Fort Collins, CO (USA). Dept. of Range Science. [1990]. 44p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER60612. Order Number DE90008640. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Plant community development is a dynamic process that results from the responses of those organisms present at the site to a constantly fluctuating environment created by the interaction of variations in climatic, edaphic, and biotic factors imposed on the physio-geographic matrix of the site. Too often, this process of community development is studied only in relation to primary producers. Our studies are based on the premise that plant community development is closely linked to the coupling of decomposers with primary producers through direct and indirect mutualistic interactions. Therefore, plant community development is a process that can be explained only by understanding the simultaneous and closely interdependent development of primary producer and decomposer subsystem. To increase our understanding of these development relationships, our studies are investigating changes in composition, structure, and activity of soil microflora and fauna; quantity, quality, and decomposition rate of litter; and nutrient availability levels in the soil, and relating these changes to plant community development patterns within a semiarid shrubland ecosystem. 34 refs., 2 figs., 7 tabs.

24390 (DOE/ER/60809–1) **Influence of sorption/desorption processes on the bioavailability of organic contaminants.** Boyd, S.A.; Guerin, W.F. Michigan State Univ., East Lansing, MI (USA). Dept. of Crop and Soil Sciences. [1990]. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER60809.

Order Number DE90008847. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The environmental fate for many non-ionic organic contaminants is a function of both their transport and their transformation. During the first eight months of this project, we have taken a systematic approach to addressing the question of how sorption of organic contaminants to soils affects their bioavailability to microbial degraders. 10 figs.

24391 (FRNC-TH–3467) **Nuclear energy: biological effects and environmental impact.** Boonefaes, M. Lille-2 Univ., 59 (France). 1987. 167p. (In French). Order Number DE90762017. Available from NTIS (US Sales Only), PC A08/MF A01.

This thesis is concerned with the large development of nuclear power plants and the recent nuclear catastrophe which has made clear how the hazards resulting from radioactivity affect public health and the environment. Environmental effects of nuclear power plants operating in normal conditions are small, but to obtain nuclear power plants of reduced radioactivity, optimization of their design, construction, operation and waste processing plays a decisive role. Biological effects of ionizing radiations and environmental impacts of Nuclear Power plants are developed.

24392 (NIPER–320, pp. 197-203) **Degradation, interaction, and fate of wastes disposed by deep-well injection.** Madden, M.P.; Collins, A.G. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Oct 1988. In *National Institute for Petroleum and Energy Research, 1987 annual report.* Order Number DE88001234. Available from NTIS, PC A23/MF A01.

Deep-well injection accounts for about 80% of all wastes disposed, about 5% is disposed of in landfills, and the remaining 15% by other methods. All secondary and tertiary oil recovery methods involve injection of fluids to increase oil recovery. These figures indicate that deep-well injection must receive adequate and knowledgeable research to ensure that regulations are realistic. A protocol for examination of the results of injecting a waste into a formation was developed. The protocol was applied to cores from the Frio formation. Phenol-containing solutions were passed through the core. No evidence of reaction was obtained. Measurements were made at various concentrations and temperatures to determine the effect of phenol adsorption on the core.

24393 (ORNL/RASA–88/59) **Results of the radiological survey at Diebold Safe Company, 1550 Grand Boulevard, Hamilton, Ohio (HO001).** Foley, R.D.; Floyd, L.M. Oak Ridge National Lab., TN (USA). Feb 1990. 19p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90009012. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

At the request of the US Department of Energy (DOE), a group from Oak Ridge National Laboratory conducted investigative radiological surveys at Diebold Safe Company, 1550 Grand Boulevard, Hamilton, Ohio in 1988 and 1989. The purpose of the surveys was to determine whether the property was contaminated with radioactive residues, principally ^{238}U. The surveys included gamma scans; direct and transferable measurements of alpha, beta, and gamma radiation levels; and dust, debris, air, and soil sampling for radionuclide analyses. 6 refs., 6 figs., 5 tabs.

24394 (ORNL/TM–11182) **Results of the preliminary radiological survey at the former Diamond Magnesium Company site, Luckey, Ohio (DML001).** Foley, R.D.; Crutcher, J.W. Oak Ridge National Lab., TN (USA). Feb 1990. 21p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90008600. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

As part of the Formerly Utilized Sites Remedial Action Program, the US Department of Energy (DOE) is implementing a radiological survey program to determine the radiological conditions at sites that were used by the department's predecessor agencies. One such site is the former Diamond Magnesium Company facility in Luckey, Ohio. The preliminary radiological survey discussed in this report was conducted at the request of DOE by members of the Measurement Applications and Development group of Oak Ridge National Laboratory in December 1988. The former Diamond Magnesium Company site in Luckey, Ohio, was used as a magnesium reduction plant during World War 2. It was closed in 1945 and reopened in 1949 as a beryllium production facility, operated by Brush Wellman for the US Atomic Energy Commission. The preliminary radiological survey included: a surface gamma scan of part of the property outdoors, collection of surface and subsurface soil samples, and collection of water samples. Laboratory analysis of soil samples showed concentrations of ^{226}Ra in excess of applicable DOE guidelines. A follow-up, detailed survey is recommended. 9 refs., 10 figs., 4 tabs.

24395 (PB–90-134180/XAB) **Review of plant uptake of 2,3,7,8-TCDD from soil and potential influences of bioavailability.** Kew, G.; Schaum, J.L.; White, P.; Evans, T.T. Environmental Protection Agency, Washington, DC (USA). Office of Health and Environmental Assessment. c Aug 1989. 8p. (EPA–600/D-89/270). Available from NTIS, PC A02/MF A01.

Volatilization of 2,3,7,8-TCDD from soil and resorption on foliage represents a significant route of contamination. Some studies indicate low-level uptake, translocation from roots to foliage and transpiration from foliage, while one shows more than 95% of 2,3,7,8-TCDD associated with edible fruits and with tubers is found in peels. Differences in bioavailability from different soils might account for some inconsistencies between existing studies, suggesting additional information useful in reporting future work.

24396 (PB–90-134412/XAB) **Use of flexible membrane liners in hazardous and nonhazardous landfills.** Landreth, R.E. Environmental Protection Agency, Cincinnati, OH (USA). Risk Reduction Engineering Lab. 1989. 16p. (EPA–600/D-89/234). Available from NTIS, PC A03/MF A01.

The U.S. Environmental Protection Agency (EPA) was mandated by the U.S. Congress to develop standards for the management of both hazardous and nonhazardous waste in a manner that would protect human health and the environment. Research and experience indicate that a properly designed, constructed, and operated landfill can provide alternative to safely dispose of waste. Use of a double, composite flexible membrane liner (FML) has been found to best protect the surrounding environment. The discussion that follows relates to the current status of the FML.

24397 (PB–90-135260/XAB) **Accumulation of poly-beta-hydroxybutyrate in a methane-enriched, halogenated hydrocarbon-degrading soil column: implications for microbial community structure and nutritional status.** Nichols, P.D.; White, D.C. Commonwealth Scientific and Industrial Research Organization, Hobart (Australia). Div. of Oceanography. c 1989. 11p. Available from NTIS, PC A03/MF A01.

Pub. in Hydrobiologia, Vol. 176/177, 369-377(Jun 1989).

The prokarotic, endogenous storage polymer poly-B-hydroxybutyrate (PHB) accumulated in soil from a methane-enriched, halogenated hydrocarbon-degrading soil column. Two strains analyzed of the type II methanotroph Methylobacterium organophilum were found to contain PHB, with PHB/PLFA ratios similar to those determined for the methane-enriched soil column, suggesting that methanotrophic bacteria enriched in the methane-amended column produced PHB. Control soil and sodium azide-inhibited material, in which methanotroph markers were below detection, did not contain PHB. Biochemical assays, based on the differences observed, can be used to monitor shifts in microbial biomass, community structure and nutritional status of systems used to model microbial biotransformation processes. The study illustrates that biochemical procedures have the potential to monitor the stimulated populations of a native soil microbial community capable of degrading pollutants.

24398 (PB–90-135492/XAB) **Photolysis of octachlorodibenzo-p-dioxin on soils: Production of 2,3,7,8-tcdd.** Miller, G.C.; Hebert, V.R.; Miille, M.J.; Mitzel, R.; Zepp, R.G. Nevada Univ., Reno, NV (USA). Dept. of Biochemistry. c 1989. 12p. Available from NTIS, PC A03/MF A01.

Pub. in Chemosphere, Vol. 18, No. 1-6, 1265-1274(Jun 1989).

Photolysis of octachlorodibenzo-p-dioxin (OCDD) on soils results in production of the lower chlorinated dibenzo-p-dioxins, notably 2,3,7,7-tetrachloro-dibenzo-p-dioxin (2,3,7,8-TCDD), 1,2,3,7,8-pentachlorodibenzo-p-dioxin (1,2,3,7,8-PCDD) and three

hexachlorodibenzo-p-dioxin isomers substituted at the 2,3,7,8-positions. Photodechlorination is favored at the lateral positions for the H6CDD and P5CDD congeners, based on the relative yields of the various isomers produced. The mean depth of photolysis of OCDD in the two soils examined varied between 0.06 and 0.13 mm.

24399 (PB–90-136029/XAB) **Health assessment for Revere Textile Prints Corporation, Sterling, Windam County, Connecticut, Region 1. CERCLIS No. CTD004532610. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 1990. 8p. Available from NTIS, PC A02/MF A01.

The Revere Textile Prints Corporation (RTP) Site is listed by the U.S. Environmental Protection Agency on the National Priorities List. Over 1,500 drums leaked contaminants such as dyes, paints, solvents, and metals on the ground. Preliminary on-site sampling results have identified toluene, 1,1,2 trichloroethylene, 1,1,1 trichloroethane, ethane, and methanol (1,500 ppb) in groundwater. On-site surface water sampling results have detected 1,1,2 trichloroethylene and magnesium. Monitoring well water results identified calcium, magnesium, manganese, and antimony. On-site sampling results have identified ethyl benzene, xylene, and barium. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances. Exposure is possible through ingestion and direct contact with contaminated groundwater, surface water, and soil.

24400 (PB–90-136045/XAB) **Health assessment for Cannons Engineering Corporation (CEC) Bridgewater NPL (National Priorities List) Site, Bridgewater, Plymouth County, Massachusetts, Region 1. CERCLIS No. MAD079510780. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 17 Apr 1989. 28p. Available from NTIS, PC A03/MF A01.

The Cannons Engineering Corporation (CEC) Site is located in Plymouth County, Massachusetts. The site was previously used to store and incinerate a variety of hazardous wastes including volatile organic compounds (VOCs), semi-volatile organic compounds (semi-VOCs), polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), pesticides, and metals. The site soils, sediments, buildings, groundwaters and surface waters are contaminated with the above compounds in varying degrees. The site soils appear to be the most contaminated. The on-site groundwaters are contaminated with VOCs and semi-VOCs. The Site in its current state of contamination poses a potential health concern via ingestion, inhalation, and dermal contact with on-site soils, sediments and residual contaminants present in the underground waste storage tanks.

24401 (PB–90-136102/XAB) **Health assessment for Hocomonco Pond, Westborough, Massachusetts, Region 1. CERCLIS No. MAD980732341. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 22 Apr 1985. 7p. Available from NTIS, PC A02/MF A01.

The material submitted on the Hocomonco Pond Site has been reviewed within the Superfund Implementation Group, Center for Environmental Health, Centers for Disease Control. The report appears to have adequately considered the possible routes of human exposure pertinent to concerns of health significance based upon the sample results available. Additional fish samples from the ponds are necessary to determine the possible human health significance of food chain contamination. The contamination of primary significance is that of creosote in the soils and sediments of the site. The groundwater sampled, in general, was reportedly not contaminated and not being locally consumed. It would therefore, appear that the fact that the subsurface soil is highly contaminated poses little public health threat.

24402 (PB–90-141466/XAB) **Health assessment for Pepper Steel and Alloy Company, Medley, Florida, Region 4. CERCLIS No. FLD032544587. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 29 Sep 1983. 9p. Available from NTIS, PC A02/MF A01.

Pepper Steel & Alloy Company (Pepper Steel) is a scrap metal and recovery facility. In 1975 mineral oil and grease spillage in the ground was detected. In 1977 polychlorinated biphenyls (PCBs) were detected in soil samples. The concentrations of PCBs found at several locations in the area are well below the 50 ppm EPA standard for soil removal, with the exception of area A northeast of and remote from Pepper Steel. There is general agreement that no spread of PCBs has occurred horizontally or vertically or to surface and well water. Rather, the data suggest that PCB-contaminated waste soil has been dumped at various locations. Hence, the local situation of PCBs not detectable or just above the detection level is consistent with the opinion that the soil contamination had not been spread to water, despite the long duration. As the only exposure is apparently exposure to contaminated soil and directly to transformer oil, both in an occupational setting, the appropriate control measures could be removing the contaminated soil and controlling work conditions through the Occupational Safety and Health Administration. Whether a study should be done on the possibility of reproductive and other health effects is an issue for the National Institute for Occupational Safety and Health.

24403 (PB–90-141524/XAB) **Health assessment for Sapp Battery Salvage, Jackson County, Florida, Region 4. CERCLIS No. FLD980602882. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 11 Jul 1986. 14p. Available from NTIS, PC A03/MF A01.

Changes to the calculation of acceptable soil levels (ASL) for priority heavy metals at the Sapp Battery National Priorities List site in Jackson County are discussed. Original calculations assumed that the most sensitive population for exposure would be small children in the area and that as a result of hand-to-mouth behavior, a 15 kg child might ingest 1 gram of contaminated soil per day. Recommended maximum contaminant levels of 20 micrograms/l of drinking water and an assumed soil ingestion of 1 gram will result in a calculated ASL of 80 mg/kg (ppm) for lead. Modifications to the ASLs for cadmium and antimony are required due to the change in the assumption of soil ingestion. By setting clean-up standards to these ASL values, persons possibly coming into daily contact with the Sapp Battery site will not be expected to suffer short- or long-term detriments to health.

24404 (PB–90-141599/XAB) **Health assessment for Tri-City Oil Conservationist Corporation, Temple Terrace, Florida, Region 4. CERCLIS No. FLD070864541. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 7 Apr 1989. 11p. Available from NTIS, PC A03/MF A01.

The Tri-City Oil Conservationist Corporation (Tri-City) National Priorities List (NPL) Site is located in Temple Terrace, Hillsborough County, Florida. The site is located in a commercial area. There were volatile organic compounds and several heavy metals present in the soil. The Record of Decision (ROD) signed September 1987 recommended a no action remedial alternative for the site. The recommendation is based on the success of the removal actions conducted prior to the development of the ROD. Tri-City was deleted from the NPL on September 1, 1988.

24405 (PB–90-141722/XAB) **Health assessment for Newport Dump Site, Campbell County, Kentucky, Region 4. CERCLIS No. KYD991277112. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 4 Dec 1986. 14p. Available from NTIS, PC A03/MF A01.

The Newport Dump Site is located in Campbell County, Kentucky, within the City of Wilder. The site was formerly a municipal landfill owned and operated by the City of Newport from the late 1940s until operations ceased in 1979. The principle contaminants of concern at the site are: arsenic, barium, chromium, nickel, benzo(a)pyrene, toluene, and polychlorinated biphenyls. Although the site does not seem to merit any but very limited public health concern, the limited time frame for which environmental monitoring data is encompassed may not be representative.

24406 (PB–90-143801/XAB) **Health assessment for Marjol Battery and Equipment Company, Throop Borough, Lackawanna County, Pennsylvania, Region 3. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 16 Aug 1988. 10p. Available from NTIS, PC A02/MF A01.

The Marjol Battery and Equipment Company (Marjol) site is located in Throop Borough, Lackawanna County, Pennsylvania. A

battery crushing and lead recovery facility operated there from 1962 to 1980. Acidic wastes and lead wastes were discharged to a drainage ditch and battery cases were deposited in an unlined landfill on-site. The soil and sediment sampling has indicated high concentrations of lead are present both on-site and off-site. Water analysis data was not available. The site is of public health concern because of the risk to human health resulting from the exposure to hazardous substances at concentrations that may result in adverse health effects.

24407 (PB–90-144197/XAB) **Health assessment for Aladdin Plating Site, Chinchilla, Pennsylvania, Region 3. CERCLIS No. PAD075993378. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 19 Jul 1988. 8p. Available from NTIS, PC A02/MF A01.

The Aladdin Plating Site consists of a former plant, operating from 1947 to 1982, for electroplating of chromium, nickel, and copper using cyanide solutions. Electroplating wastes were deposited in two shallow surface settling ponds. To date, identified contaminants of concern include chromium, copper, cyanide, lead, nickel, antimony, and barium in on-site soil. Potential environmental pathways include waste materials, soil, air, and consumable plants and animals. Potential human exposure includes ingestion of plants or animals which have accumulated contaminants from the site; contaminated soil ingestion by children; inhalation of contaminants carried in re-entrained dust; and dermal contact with contaminated soil or waste materials. If groundwater and surface water data adequately represent potential for human health hazards from the site, these media do not constitute environmental or human exposure pathways of concern.

24408 (PB–90-144692/XAB) **Health assessment for Wade Hazardous Waste Site (WHWS) National Priorities List (NPL) Site, Chester, Pennsylvania, Region 3. CERCLIS No. PAD980539407. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 11p. Available from NTIS, PC A03/MF A01.

The Wade Hazardous Waste Site (WHWS) is located on the Delaware River, in Chester, Pennsylvania. From 1950 until the early 1970s the site was the location for a rubber recycling operation. During the early 1970s the site was converted to an unpermitted industrial waste storage and disposal facility. Remedial actions specified in the WHWS Record of Decision included: removal, decontamination, and disposal of on-site tires and tankers; removal of on-site waste piles; demolition of buildings; leveling, filling, and grading of the site; removal of soil with volatile organic compounds greater than 100 parts per million (ppm) or levels of base neutral-acid-extractable compounds greater than 100 ppm; and covering of the site with topsoil and seeding of the cap. Site remediation minimized the likelihood of human exposure to on-site contaminants; however, site investigations failed to determine the presence or nature of off-site soil contamination. The site may be a potential public health concern if the off-site soils are contaminated. Humans may be exposed through dermal absorption, ingestion, or inhalation of off-site soil contaminants.

24409 (PB–90-144809/XAB) **Health assessment for Shriver's Corner, Gettysburg, Pennsylvania, Region 3. CERCLIS No. PAD980830889. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 12 Mar 1986. 9p. Available from NTIS, PC A02/MF A01.

The Agency for Toxic Substances and Disease Registry has been requested by the Environmental Protection Agency to address the necessity for an immediate removal action of soil containing contaminants at the Shriver's Corner Site, Gettysburg, Adams County, Pennsylvania. Thallium soil concentrations exceed the level that may be of public health significance. The soil sample from station 04 demonstrated a lead concentration of 1540 mg/kg. Elevated blood lead concentrations in children have been demonstrated by the Centers for Disease Control to increase when soil concentrations are greater than 500-1000 parts per million (ppm or mg/kg). The Shriver's Corner Site is of public health concern due to the potential for direct contact with contaminated soil. However, if access to the site is restricted exposure to the contaminants of concern would be eliminated and an immediate removal action would not be necessary to mitigate exposure.

24410 (UCRL–21337) **Laboratory explosions in rock: Motion, strain, and stress.** Trulio, J. Lawrence Livermore National Lab., CA (USA). 24 Nov 1989. 107p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (ATR–89-68-01). Order Number DE90008785. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

If radial motion be prescribed at the inner boundary of a spherical mid-field, then, for a viscoelastic medium, the field beyond that boundary can be represented in explicit integral form (with an auxiliary nonlinear dispersion relation). That result holds for the simplest of the media with which one might hope to account for mid-fields – but then, complex models of geo-materials, never hard to conceive, have become commonplace in "theories" of explosive events. Indeed, now that high-speed computers allow us to generate numerical solutions with them, the herd of soil and rock models has far outrun our knowledge of whether the models' assumptions are obeyed. For, although addition takes $\sim 10^{-9}$ of the time it took 50 years ago, it's doubtful that a good experiment now takes less than a tenth of the time it did then; great strides in technology have been offset by greater complexity of the questions asked of nature (in part, perhaps, because the very advances noted have encouraged brute-force approaches to both theory and experiment). The program under which the present work was done aims to correct this imbalance. Setting aside the question of differences between on-site material and laboratory samples of that material, it seeks to learn, in the laboratory, what stress-strain relations granite and salt actually follow over the mid-field.

24411 Innovative waste management technologies. Jolley, R.L. (Oak Ridge National Lab., TN (USA)). *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 29(1): 125-126 (1989). DOE Contract AC05-84OR21400. (CONF-8904177–: Symposium on innovative waste management technologies, Dallas, TX (USA), 9-14 Apr 1989).

The advent of the industrial and chemical revolution brought into existence chemicals and materials different from any other previously known wastes. Currently used methods and recently proposed innovative methods to dispose of new types of wastes (e.g. PCBs, DDT, and the newly created fission product elements, and nonbiodegradable materials as plastics) are reviewed in this paper. Conventional and innovative treatment methods may be classified according to the nature of the process: physical, chemical biological, thermal, or fixation/stabilization. For example, detoxification methods may involve (1) physical treatment (filtration, incineration, pyrolysis, or distillation); (2) chemical treatment (neutralization, oxidation, reduction, or precipitation); and (3) biological treatment (aerobic or anaerobic digestion). Immobilization and stabilization techniques, including in situ methods (e.g., grout formation, vitrification) are being developed for especially hazardous wastes.

24412 Engineered waste disposal: Future prospects and challenges. Rivera, A.L. (Oak Ridge National Lab., TN (USA)); DePaoli, S.M. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 29(1): 136-138 (1989). (CONF-8904177–: Symposium on innovative waste management technologies, Dallas, TX (USA), 9-14 Apr 1989).

A systems approach to the management of low-level, hazardous, and mixed waste can be described by three major steps: (1) treatment and/or packaging prior to disposal and effluent discharge with the objective of volume reduction, detoxification, or stabilization of the waste; (2) selection and construction of additional engineered barriers with the objective of preventing or controlling the migration of the waste from the disposal facility; and (3) locating the disposal facility at a site with appropriate hydrogeological properties with the objective of using natural barriers to stop or reduce the migration of waste. Identification and definition of uncertainties and their potential impacts are critical elements of technical information packages supporting innovative engineered waste disposal concepts.

24413 Leach tests at Savannah River Laboratory for radioactive and nonradioactive nuclear waste glasses. Bibler, N.E. (E.I. du Pont de Nemours and Co., Savannah River Lab., Aiken, SC (USA)); Jantzen, C.M. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 29(1): 141-143 (1989). DOE Contract AC09-76SR00001. (CONF-8904178–: Symposium on leaching tests, Dallas, TX (USA), 9-14 Apr 1989).

This report details tests at the Savannah River Plant to immobilize high-level nuclear wastes which are currently being stored as caustic slurries. The slurries will be immobilized into borosilicate glass. Savannah River Laboratory (SRL) has developed and performed a variety of leach tests on both radioactive glass containing actual nuclear waste and nonradioactive glass containing simulated waste. Several of the leach tests at SRL have involved modifications of the MCC-1 leach test protocol developed by the Materials Characterization Center. Special tests discussed are the tests demonstrating that radioactive and nonradioactive glass leach similarly, tests that simulate a saturated tuff repository environment, and tests at a low Eh that simulate a saturated basalt repository.

24414 Glass composition effects on the results of MCC-1, MCC-3 and pulsed-flow leach tests. Barkatt, A. (Catholic Univ. of America, Washington, DC (USA)); Adiga, R.; Adel-Hadadi, M.A.; Barkatt, A.; Feng, X.; Sousanpour, W. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 29(1): 144-148 (1989). (CONF-8904178–: Symposium on leaching tests, Dallas, TX (USA), 9-14 Apr 1989).

Glass composition effects on the results of MCC-1, MCC-3 and pulsed-flow leach tests are summarized. Major components of the glasses studied are included. The leachant in all cases was deionized water and the temperature was 90°C. Test duration of the MCC-1 and MCC-3 was 28 days. The total time in the pulsed-flow test was 112 days. In the MCC-1 test, the results indicate that the forward rate characteristic of the kinetics of leaching in unsaturated environments is relatively independent (within a factor of 2) of such variations. The MCC-3 results reflect the extent of glass dissolution under conditions where the extent of interaction is large enough to cause the solution in contact with the glass to approach saturation with respect to silica and other scarcely soluble components. The pulsed-flow results show that at longer periods of time the dependence of leachate composition on glass composition decreases again and that leachate concentrations approach stabilization at levels which are much lower than the MCC-3 limits.

24415 Development of a nuclear waste glass product consistency test. Plodinec, M.J. (E.I. DuPont de Nemours and Co., Aiken, SC (USA)); Jantzen, C.M.; Bibler, N.E. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 29(1): 149-151 (1989). (CONF-8904178–: Symposium on leaching tests, Dallas, TX (USA), 9-14 Apr 1989).

This report summarizes the development of the Defense Waste Processing Facility (DWPF) Product Consistency Test (PCT). In the DWPF the residue of over thirty years of reprocessing of nuclear fuels for national defense purposes will be immobilized in durable borosilicate glass. To satisfy the requirements for radionuclide release, a leach test is needed which is easily reproducible, can be performed remotely on highly radioactive samples, and can yield reliable results rapidly. Results from initial tests are reported. The initial tests lasted for seven days at 90°C. Round robin test results are also discussed.

24416 Repository relevant testing applied to the Yucca Mountain project. Bates, J.K. (Argonne National Lab., IL (USA)); Gerding, T.J. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 29(1): 152-154 (1989). (CONF-8904178–: Symposium on leaching tests, Dallas, TX (USA), 9-14 Apr 1989).

This report discusses the development of the Yucca Mountain Project (YMP) Unsaturated Test. This test was developed because the potential repository site, in Yucca Mountain, Nevada, horizon is located in the unsaturated zone forcing development of test methods to monitor waste form reaction under conditions of intermittent water contact. This test represents an effort to perform site-relevant testing. With this test, the waste form, either glass or spent reactor fuel, is held in a metal retainer made of the same material as used to contain the waste in the repository. This waste package assembly (WPA) is then positioned in a metal vessel and contacted periodically by repository water that is dripped in the WPA through an inject tube. Test results of both glass and Uranium Dioxide waste forms are presented.

24417 Statistical evaluation of process parameters affecting properties of ICPP (Idaho Chemical Processing Plant) ceramic waste forms. Staples, B.A. (Westinghouse Idaho Nuclear Co., Idaho Falls (USA)). *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 29(1): 155-157 (1989). (CONF-8904178–: Symposium on leaching tests, Dallas, TX (USA), 9-14 Apr 1989).

At the Idaho Chemical Processing Plant (ICPP) high-level liquid waste generation by reprocessing defense fuels are converted to a granular solid by fluidized bed calcination. A primary option to immobilize calcined ICPP High-Level Waste (HLW) is to form a glass-ceramic by hot isostatic pressing (HIPing) of a calcine-additive mixture. Laboratory-scale testing indicates that the resulting glass-ceramic product containing as much as 70 wt% calcined waste is durable and well densified. The formation of desirable properties in products depends largely on HIPing conditions which are determined by the control of process parameters. This study was performed to identify on a laboratory scale the process parameters which best achieve the desired properties in the HIPed glass-ceramic waste form. In order to minimize testing, to perform a simultaneous investigation of several product properties and to obtain a useful estimate of experimental error a twelve-run Plackett-Burman screening design was applied to identify the dominant parameter. The independent process parameters screened and their low and high levels are given in Table I. Substitution of the levels of each parameter into the Plackett-Burman matrix results in the design given in Table II. Through application of the Plackett-Burman screening design methodology on the product responses it was determined that mixing has a dominant effect on product total mass loss rate as determined by the 14-day MCC-1 leach test and on the pH of the generated leachate. This verified the importance of mixing in forming useful products and indicates that unmixed products will have high total mass loss rates as well as other inferior properties. Experiments are presently in progress to determine the importance of the remaining parameters based on using well mixed samples.

24418 Leach testing of cementitious waste forms to generate data for long-term performance projections. Serne, R.J. (Pacific Northwest Labs., Richland, WA (USA)); Criscenti, L.J. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 29(1): 158-159 (1989). (CONF-8904178–: Symposium on leaching tests, Dallas, TX (USA), 9-14 Apr 1989).

Predicting the long-term performance of low-level nuclear wastes that have been solidified in cementitous materials is the subject of this report. The authors approach has included use of several types of leach tests to help elucidate release mechanisms. Test ANS16.1 has been modified by using actual groundwater as opposed to distilled water as the leachant. In addition static leach tests, once-through flow leach test and combined leach/adsorption tests where the waste form is surrounded by sediment to simulate shallow land burial have been performed. Geochemical modeling of leachates from the various tests suggest that many major constituents in cement and grout waste forms and some trace metal contaminants may be solubility controlled. Using hypothetical hydrologic scenarios representative of arid Western United States disposal sites, the difference in mass flux for selected constituents are discussed assuming diffusion control in one case and solubility in a second case.

24419 Leach characterization of phosphate-sulfate waste grouts. Rebagay, T.V. (Westinghouse Hanford Co., Richland, WA (USA)); Dodd, D.A. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 29(1): 160-163 (1989). (CONF-8904178–: Symposium on leaching tests, Dallas, TX (USA), 9-14 Apr 1989).

Testing of grouts prepared from non-hazardous low-level radioactive liquid wastes for their mechanical stability and leach resistance to water is summarized. Attainment of a specified minimum leachability index for each species of interest is one of the requirements for acceptance of a grout formulation. The waste used in this investigation came from one of the tanks containing phosphate and sulfate waste (PSW) solutions resulting from decontamination operations and the fuel storage basin cleanup process at the Hanford N Reactor. Test methodology is outlined. Leachates generated were analyzed for metallic species by inductively coupled plasma-atomic emission spectroscopy (ICP-AES) and/or by atomic absorption

spectroscopy (AAS). Anionic species were determined by ion chromatography (IC). Radiochemical characterizations were conducted using gamma energy analysis for gamma-emitting radionuclides and liquid scintillation for alpha and beta emitters. Results indicate that Hanford phosphate-sulfate waste grouts can be designated/classified as nonhazardous and may be used as input for computer codes in the prediction of long-term chemical stability of the grout against infiltration by water.

24420 Reflections on the validation of physicochemical mechanisms applied to the interpretation of leaching test results. Cote, P.L. (Environment Canada, Burlington, Ontario (Canada)); Anders, O.U.; Godbee, H.W. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 29(1): 181 (1989). (CONF-8904178–: Symposium on leaching tests, Dallas, TX (USA), 9-14 Apr 1989).

Laboratory leaching tests provide leachate concentrations which are used for such purposes as: (1) determination of suitability of a waste form for disposal under some conditions (i.e., a go or no-go measurement); (2) comparison and evaluation of solidified/stabilized waste forms (e.g., a figure of merit); (3) prediction of the concentration of a species under field conditions; (4) estimation of the potential (maximum) amount of a species released; (5) calculation of a source term (flux) for groundwater migration modeling; and (6) data for elucidating the mechanisms of leaching. Interpretation of leaching data involves not only ensuring the quality of the data (applicability, accuracy, precision, significance, etc.) but also reduction of the data to units that are correct and consistent for the model or system being described. This paper is an assessment of these and other considerations (e.g., thermodynamic and kinetic) deemed necessary for interpretation of leaching tests. These reflections will emphasize the use of time-independent (thermodynamic) and time-dependent (kinetic) considerations in the design, performance, and interpretation of leaching tests. For example, phase equilibria and the effects of chemical reactions on such equilibria will be addressed. Such considerations are generally acknowledged to be crucial to the understanding of leaching tests. The importance of parameters or factors such as: (1) the total amount of a species initially in the waste form; (2) the form, or forms, of the species (e.g., soluble, sparingly soluble, anionic, cationic, colloidal, etc.); (3) relative volumes of waste form and leachant; (4) leachant replacement (e.g., continuously, intermittently, or none); (5) shape and dimensions of waste form, and (6) the feasibility of independent corroborative experiments will be stressed.

24421 NEWBOX: A computer program for parameter estimation in diffusion problems. Nestor, C.W. Jr. (Oak Ridge National Lab., TN (USA)); Godbee, H.W.; Joy, D.S. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 29(1): 182-183 (1989). (CONF-8904178–: Symposium on leaching tests, Dallas, TX (USA), 9-14 Apr 1989).

In the analysis of experiments to determine amounts of material transferred form 1 medium to another (e.g., the escape of chemically hazardous and radioactive materials from solids), there are at least 3 important considerations. These are (1) is the transport amenable to treatment by established mass transport theory; (2) do methods exist to find estimates of the parameters which will give a best fit, in some sense, to the experimental data; and (3) what computational procedures are available for evaluating the theoretical expressions. The authors have made the assumption that established mass transport theory is an adequate model for the situations under study. Since the solutions of the diffusion equation are usually nonlinear in some parameters (diffusion coefficient, reaction rate constants, etc.), use of a method of parameter adjustment involving first partial derivatives can be complicated and prone to errors in the computation of the derivatives. In addition, the parameters must satisfy certain constraints; for example, the diffusion coefficient must remain positive. For these reasons, a variant of the constrained simplex method of M. J. Box has been used to estimate parameters. It is similar, but not identical, to the downhill simplex method of Nelder and Mead. In general, they calculate the fraction of material transferred as a function of time from expressions obtained by the inversion of the Laplace transform of the fraction transferred, rather than by taking derivatives of a calculated concentration profile. With the above approaches to the 3 considerations listed at the outset, they developed a computer program NEWBOX, usable on a personal computer, to calculate the fractional release of material from 4 different geometrical shapes (semi-infinite medium, finite slab, finite circular cylinder, and sphere), accounting for several different boundary conditions.

24422 Application of the newbox computer program to an analysis of the leaching data for several alkali metals and phenol from cementitious waste forms. Godbee, H.W. (Oak Ridge National Lab., TN (USA)); Mrochek, J.E.; Nestor, C.W. Jr.; Anders, O.U. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 29(1): 184-188 (1989). (CONF-8904178–: Symposium on leaching tests, Dallas, TX (USA), 9-14 Apr 1989).

The results from leaching tests on two different sets of solid waste forms are analyzed using NEWBOX (a computer program for parameter estimation in diffusion problems). The solid waste forms were made by incorporating the sludge from a biodenitrification process in cementitious admixtures. The solids (one set with calcium silicate and the other with sodium silicate additive) were leached using tests based on the MCC-1 and ANSI/ANS-16.1-1986 test protocols. A slightly modified MCC-1 (1-, 3-, 7-, 14-, and 28-day) procedure and the abbreviated (5-day) ANS-16.1 procedure were used with demineralized water as leachant and waste forms that were cylindrical (diameter of 2.5 cm and length of 4.5 cm).

24423 Comparison of leaching test results obtained on several vendor-prepared waste forms using the ANSI/ANS-16.1-1986 and MCC-1 protocols. Kasten, J.L. (Oak Ridge National Lab., TN (USA)); Godbee, H.W.; Gilliam, T.M. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 29(1): 189-191 (1989). (CONF-8904178–: Symposium on leaching tests, Dallas, TX (USA), 9-14 Apr 1989).

Solid waste forms prepared by vendors of solidification systems (cement or asphalt) were leached using ANSI/ANS-16.1-1986 standard 90-day test and a modified MCC-1 test (4 separate, but identical specimens, sampled sequentially after 3, 7, 14, and 28 days). The simulated wastes incorporated in these solids represent several of those designated for immobilization on the Oak Ridge Reservation of the US Department of Energy. Four nonradioactive (since radioactivity would pose a problem for the vendors) surrogate waste types were prepared: (1) a carbonate-based sludge; (2) a $CaCO_3$-$Mg(OH)_2$ based sludge; (3) a metal plating sludge; and (4) a liquid containing high nitrates. The waste forms supplied by each vendor for leaching using the MCC-1 and ANS-16.1 procedures were right circular cylinders (2.3-cm diameter x 4.5-cm length).

24424 Interpretation of leaching data for cementitious waste forms using analytical solutions based on mass transport theory and empiricism. Spence, R.D. (Oak Ridge National Lab., TN (USA)); Godbee, H.W.; Tallent, O.K.; Nestor, C.W. Jr. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 29(1): 195-198 (1989). (CONF-8904178–: Symposium on leaching tests, Dallas, TX (USA), 9-14 Apr 1989).

The analysis of leaching data using analytical solutions based on mass transport theory and empiricism is presented. The waste forms leached to generate the data used in this analysis were prepared with a simulated radioactive waste slurry with traces of potassium ion, manganese ions, carbonate ions, phosphate ions, and sulfate ions solidified with several blends of cementitious materials. Diffusion coefficients were estimated from the results of ANS - 16.1 tests. Data of fraction leached versus time is presented and discussed.

24425 Destruction and immobilization of metal-contaminated PCB sludges by gasification on an activated char from subbituminous coal. Manahan, S.E. (Univ. of Missouri, Columbia (USA)); Kapila, S.; Cady, C.; Larsen, D. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 29(1): 227-228 (1989). (CONF-890490–: American Chemical Society Division of Environmental Chemistry meeting, Dallas, TX (USA), 9-14 Apr 1989).

This paper reports a modified coal gasification process that has been developed to produce an activated carbon product (char) that has proven effective for the immobilization and/or destruction of some major types of hazardous wastes. Mixed organic-heavy metal sludges can be treated with the char. Details of how the char is

produced are outlined. Important advantages are mentioned. Three specific applications of the char hazardous waste treatment are summarized.

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Refer also to citation(s) 23374, 23375, 23378, 23380, 23381, 23382, 23383, 23384, 23385, 23386, 23387, 23388, 23389, 23391, 23393, 23491, 23492, 23495, 23496, 23497, 23498, 23499, 23500, 23501, 23502, 23503, 23528, 23576, 23615, 23616, 23617, 23659, 23660, 23661, 23662, 23663, 23664, 23665, 23684, 23758, 23787, 23830, 24012, 24356, 24370, 24388, 24391, 24399, 24400, 24403, 24413, 24414, 24415, 24416, 24417, 24418, 24419, 24420, 24421, 24422, 24423, 24424, 24790, 24791, 24792, 24793, 24794, 24795, 24796, 24797, 24798, 24799, 24800, 24801, 24802, 24803, 24804, 24805, 24806, 24807, 24808, 24809, 24810, 24811, 24812, 24813, 24814, 24815, 24816

24426 (AD-A–215239/5/XAB) **Leaching of metal pollutants from four well casings used for ground-water monitoring. Special report.** Hewitt, A.D. Cold Regions Research and Engineering Lab., Hanover, NH (USA). Sep 1989. 15p. (CRREL-SR–89-32). Available from NTIS, PC A03/MF A01.

Polytetrafluoroethylene (PTFE), polyvinylchloride (PVC), stainless steel 304 (SS 304) and stainless steel 316 (SS 316) well casings were tested for suitability for ground-water monitoring. A laboratory experiment, testing for the leaching of Ag, As, Ba, Cd, Cr, Hg, Pb, Se and Cu, was run in triplicate by exposing sections of the well casings to ground water for four periods ranging from 1 to 40 days. The results showed that PTFE did not leach any of the nine analytes studied, while SS 316 and PVC showed significant leaching of Cr, Cd and Pb; SS 316 also leached significant amounts of Ba and Cu. Stainless steel 304 showed significant leaching of Cr and Pb. In every case where contamination was observed, the release of metal analyte, when averaged over all of the exposure periods, was the greatest from either SS 304 or SS 316. Released contaminants were sorbed back onto the well casings in several cases.

24427 (AD-A–215731/1/XAB) **Water sludge management for military installations. Final report.** Johnson, N.M.; Scholze, R.J.; Liehr, S.; Temkar, P.M.; Smith, E.D. Army Construction Engineering Research Lab., Champaign, IL (USA). Nov 1989. 93p. (CERL-TR-N–90/04). Available from NTIS, PC A05/MF A01.

Water treatment plants on military installations are required to meet Federal regulations covering sludge disposal. Like civilian plants, these installations had previously discharged the sludge into surface waters or wastewater streams. Compliance with the regulations has now demanded that plants minimize sludge production and consider alternatives to disposal, such as recycling. This report reviews the state of the art in treatment plant operation and maintenance to help installation Directorates of Engineering and Housing determine optimal practices for their individual plants. This review covers applicable regulations, a characterization of types of sludge produced, disposal options, economics, and possible modifications to existing plant design and O&M procedures.

24428 (BNWL-CC–1386) **Radiation survey of islands and beaches on the Columbia River between Hanford and the 300 area.** Bovington, J.R. Pacific Northwest Lab., Richland, WA (USA). 15 Mar 1966. 7p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. Order Number DE90008588. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A radiation survey of the islands and beaches of the Columbia River between Hanford and Richland was made in April 1965 as a follow-up survey to previous surveys. Included in the surveys were measurements of the dose rates at selected locations and general contamination surveys. 1 fig., 1 tab.

24429 (BNWL-CC–1411) **Impact of proposed Washington State water quality standards on Hanford.** Corley, J.P.; Selby, J.M. Pacific Northwest Lab., Richland, WA (USA). 3 Nov 1967. 13p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. Order Number DE90008587. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The proposed regulation relating to Water Quality Standards for Interstate and Coastal Waters of the State of Washington contains eight standards. Standards are established for Total Coliform Organisms, Dissolved Oxygen, Temperature, Radioactivity, pH, Turbidity, Toxic or Deleterious Material, and Aesthetic Values. The Columbia River from the Washington-Oregon border to Priest Rapids is designated as class A water. Additionally, special temperature requirements are defined for this reach of the river. This report reviews the measured and projected conditions in this reach of the river in relation to these standards. 4 figs.

24430 (BNWL-CC–1436) **Report to the Working Committee for Columbia River Studies on progress since August, 1964 for projects carried out by Battelle-Northwest.** Foster, R.F. (ed.). Pacific Northwest Lab., Richland, WA (USA). 29 Nov 1967. 15p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. Order Number DE90008592. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The work described in this progress report is in support of one or more of the "Objectives of the Columbia River Study." These include: define the importance of temperature in relation to survival of important species of fish and lower aquatic life forms; define the effect of radioactivity and/or temperature on the *C. columnaris*; define the mechanisms involved in the transport of radionuclides in water and their removal from the water; and define the movement of radionuclides through aquatic populations.

24431 (BNWL-CC–2253) **Operating instructions for the gross gamma and iodine monitors at the Automatic Columbia River Monitoring Station.** Denham, D.H. Pacific Northwest Lab., Richland, WA (USA). 13 Aug 1969. 18p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. Order Number DE90008589. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Columbia River is used as a source of cooling water for Hanford Production reactors and as a source of irrigation and drinking water further downstream. The Automatic Columbia River Monitoring Station (ACRMS) houses instrumentation designed to provide continuous monitoring of Columbia River water for radioactivity and hexavalent chromium. The radiological monitoring system provides a continuous recording of the gross gamma and ^{131}I levels in the river, an alarm for unusual activity levels, and an automatic emergency sampling system in the event of an alarm condition. This report describes the ACRMS – the water pumping system, the radiological monitoring instrumentation, and the emergency capabilities. Although the station is designed to operate continuously and automatically, routine inspection and maintenance are required to assure proper functioning of all equipment. The following details provide general information on the operation and maintenance of the station and of the gross gamma and ^{131}I monitoring systems. 3 refs., 6 figs.

24432 (BNWL-CC–2403) **[Battelle Memorial Institute/Pacific Northwest Laboratory operating and managing contract]: Progress report on Columbia River studies, July–December 1969.** Foster, R.F.; Honstead, J.F.; Jaske, R.T. Pacific Northwest Lab., Richland, WA (USA). 13 Jan 1970. 13p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. Order Number DE90008586. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Members of the population living in the vicinity of the Hanford Plant may become exposed to radiation resulting from Plant operation through a variety of mechanisms, or pathways. This may include external exposure to radiation from radioactivity introduced into the environs with low-level radioactive effluents and radiation exposure from internally deposited radionuclides ingested with various food sources. This project investigates the pathways of exposure of members of the public to permit quantitative evaluation of the magnitude of exposure from various pathways and their summation. The study, for example, will try to evaluate the effect of effluents released to the Columbia River and the atmosphere. The resulting estimates of exposure require evaluation of how the members of the public utilize various parts of their environment, such as the Columbia River, for recreation, as a source of sanitary water, and for food production. These investigations will provide improved estimates of exposure levels experienced by local residents and strengthen confidence in effluent control provisions. The resulting dose estimates will contain fewer uncertainties with regard to the

validity of the population sample examined and the pathway parameters used to compute human exposure.

24433 (CONF-891098–6) **Evaluating effects of environmental stress on fish communities using multiresponse indicators.** Adams, S.M.; Cada, G.F.; Greeley, M.S. Jr.; Shugart, L.R. Oak Ridge National Lab., TN (USA). [1989]. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From The scientific challenge of NEPA: future directions based on 20 years of experience; Knoxville, TN (USA); 24-27 Oct 1989. Order Number DE90008563. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Most traditional approaches for assessing the effects of environmental stress on fish involve the generation of species lists, the estimation of densities of organisms, the use of acute of chronic laboratory tests, or the measurement of single or a few stress responses. Most of these approaches provide limited information needed to address fundamental National Environmental Policy Act (NEPA) issues such as the consideration of alternative actions and cumulative impacts. Use of multiresponse indicators of stress at several levels of biological organization permits identification of biologically and ecologically relevant effect, possible early detection of environmental problems, evaluation of the effectiveness of environmental restoration actions, and possible insights into casual mechanisms between stress and effects that may be ultimately manifested at the population and community level. Responses at the biochemical, physiological, histopathological, bioenergetic, and population levels were used to assess the effects of chronic contamination loading on fish communities in some East Tennessee streams. Various biochemical/biomolecular responses provided direct evidence of toxicant exposure, while bioenergetic and histopathological indicators reflected impaired population growth and reproductive potential. Within the NEPA process, use of multiresponse indicators can be an effective approach for addressing remedial actions and cumulative impacts of multiple stressors on fish communities. 11 refs., 4 figs.

24434 (DOE/ER/60773–1) **Fundamental quantitative analysis of microbial activity in aquifer bioreclamation: Second semi-annual progress report, August 1989–February 1990.** Rittmann, B.E. (Illinois Univ., Urbana, IL (USA). Dept. of Civil Engineering); Valocchi, A.J.; Baveye, P. Illinois Univ., Urbana, IL (USA). Dept. of Civil Engineering; Cornell Univ., Ithaca, NY (USA). Dept. of Agronomy. [1990]. 60p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER60773. Order Number DE90008657. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This project report contains two types of reports. The first type is a quarterly internal progress report. The purpose of the internal reports is to keep all members of the research team abreast with developments in each area. The second type is a semi-annual report that is transmitted to DOE and PNL. Its main purpose is to inform the project sponsors of the research-team's progress and plans. This report is the second semi-annual progress report. The project has four primary areas including biodegradation of poorly soluble organic contaminants, dual-limitation kinetics of electron donors and acceptors, two-dimensional modeling of biofilm reactions in nonhomogeneous porous media, and biologically induced clogging in porous media. 26 refs., 32 figs., 2 tabs.

24435 (IAEA-TECDOC–502, pp. 103-111) **Artificial and environmental tracers in the study of leakage under a dike of the Samuel Reservoir, Porto Velho, Brazil.** Roldao, J. (Universidade Federal, Rio de Janeiro, RJ (Brazil)); Lopes, N.; Stichler, W.; Zuber, A. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

An artificial tracer (^{3}H), fluorescent dyes (Uranine and Eosine) and environmental tracers (^{2}H and ^{18}O) were simultaneously used to investigate leakages under a dike in the Amazon region. Results obtained with the help of artificial tritium were in a satisfactory agreement with those obtained with environmental tracers, whereas the fluorescent dyes were unsuccessful probably due to high adsorption. (author). 4 refs, 5 figs, 1 tab.

24436 (IAEA-TECDOC–502, pp. 143-154) **Measurements of ^{18}O and ^{2}H in snow 'penitentes'.** Pena, H. (Direccion General de Aguas, Santiago (Chile)). International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

The characteristics of the energy balance for the high mountains snow of arid and semi-arid regions generate a special kind of ablation surface geometry, called "penitentes". For this surface, processes related to snow cover ablation, and specially relations between those processes and the isotope contents of snow melting water, are complex and almost entirely unknown. In this study, the modification of ^{18}O and ^{2}H contents of snow and melting water due to the presence of "penitentes" is analyzed, as well as the involved processes. With this purpose, a number of 6 "penitentes" on 2 glaciers of the Andes Mountains were sampled from 1983 to 1986. As a general result, "penitentes" show a high enrichment of heavy isotopes with time, specially for those samples taken on the "penitentes" surface. The enrichment process follows the equilibrium slope. Some possible causes of the complex isotope distribution pattern of the "penitentes" are discussed. This distribution basically seems to reflect the relative importance of melting and evaporation (sublimation) - condensation processes at the different parts of a "penitentes". (author). 10 refs, 9 figs, 1 tab.

24437 (IAEA-TECDOC–502, pp. 155-168) **Salars evaporation rates evaluation using isotope techniques, Bellavista Salar, Chile.** Grilli, A. (Ministerio de Obras Publicas, Santiago (Chile). Direccion General de Aguas); Ortiz, J.; Pollastri, A.; Aguirre, E. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

Long term evaporation rates are evaluated in different soil conditions at Bellavista Salar, using environmental isotope profiles (oxygen-18) of the unsaturated soil zone. The Barnes and Allison model was adapted to stratified soils under non-saturation conditions and for a non-isothermal permanent regime. To apply the proposed model, field data of the different variables were used and the evaporation rates were obtained adjunting the δ ^{18}O values generated by the model to those experimentally measured in the water extracted from the soil profile of the unsaturated soil zone. (author). 13 refs, 8 figs.

24438 (IAEA-TECDOC–502, pp. 169-189) **Study of leakages in the dam 'El Colorado' with isotope techniques.** Plata Bedmar, A. (International Atomic Energy Agency, Vienna (Austria)); Iraguen Iraguen, E.; Heresi Milad, N. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on

the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

The seepage under the dam El Colorado of the Colbun reservoir has been studied by means of various natural and artificial tracers. The δD-values of the water emerging at the relief wells located downstream of the dam have allowed the identification of an important groundwater flow, which does not come from the reservoir. This groundwater discharged at the valley of the river Maule prior to the construction of the reservoir. The temperature of water has proved to be an excellent tracer and has allowed the identification of the infiltration zone of an important fraction of the seepage. A zone of infiltration has been identified at the ancient bed of the river Teatinos through the displacement of a cloud of injected ^{131}I. The detection of this tracer at the emerging water was a confirmation of the interconnection. On the other hand, the infiltration rate at various zones of the reservoir has been investigated by a dilution method based on the use of a metallic bell placed at the bottom of the reservoir. Eleven interconnection experiments between piezometers and relief wells have provided information on the flow pattern under the dam and on the permeability of the porous materials through which the water infiltrates. Finally, many flow tests with ^{131}I executed inside non-emerging relief wells, have allowed the identification of a permeable deep horizon which seems to be responsible for an important fraction of the seepage and extends the whole length of the dam. (author). 4 refs, 14 figs.

24439 (IAEA-TECDOC–502, pp. 431-443) **Determination of river-bed transport with iridium-192 in the upper reaches of the river Lerma.** Gonzalez Hita, L. (Instituto Mexicano de Tecnologia del Agua, Mexico City (Mexico). Subcoordinacion de Hidraulica). International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

The upper reaches of the river Lerma discharge at an average rate of 29m^3/s into the Solis barrage, which is one of the largest in the Mexican high plateau. This barrage covers an area of 10^5 ha and is subject to problems of sedimentation, which result in an estimated reduction in useful volume of about 4.8×10^6m^3 per year. Its hydraulic characteristics are those of a torrential river; during the rainy season, almost instantaneous variations in its flow rate of 15m^3/s to 70m^3/s are recorded, and during some hours the flow rate even reaches 100m^3/s to 300m^3/s. Since radioactive tracers have proved very useful in studying river-bed transport in this type of river, one kilogram of glasses labelled with 0.685 Ci of ^{192}Ir was used to determine the quantity of solid material carried by the river to the Solis barrage. The grain size of the tracer injected was determined from a mathematical model for size distribution of the river-bed sediment. The experiment lasted 232 days and covered the whole floodwater period. A unit solid flow rate of 2.25 ± 0.66 t/m.d was estimated on the basis of the spatial integration of the tracer. For the purpose of comparison, various semi-empirical formulae (Einstein, Meyer-Peter-Mueller, Schoklitsch, Kalinske, and others) were used to calculate river-bed transport. Agreement was found between some of these results and those obtained using the radiotracer. (author). 15 refs, 5 figs, 3 tabs.

24440 (IAEA-TECDOC–502, pp. 463-476) **Critical review of single-well and multi-well nuclear tracer techniques.** Drost, W. (Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Inst. fuer Hydrologie); Moser, H. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

The review starts with a general statement what kind of parameters in groundwater hydraulics can be measured by tracer methods and how these parameters can be determined by means of other methods than tracer methods, e.g. subsurface investigations, exploration drilling, geophysical borehole logging, groundwater level measurements and pumping/recharge tests. Afterwards the general outlines of tracer techniques including radioactive tracers are summarized and special nuclear tracer techniques are described. Especially the single well techniques dilution logging, direction logging, flow meter measurements, and single well pulse (logging) are pointed out as fruitful methods using radioactive tracers. Concluding remarks concern the state of the application of nuclear tracer logging in comparison with conventional methods. (author). 9 refs, 2 figs, 1 tab.

24441 (PB–90-126467/XAB) **Preliminary data summary for the solvent-recycling industry.** Anderson, D.; DiCianna, D.; Yance, J.; Tarnay, A. Environmental Protection Agency, Washington, DC (USA). Office of Water Regulations and Standards. Sep 1989. 86p. (EPA–440/1-89/102). Available from NTIS, PC A05/MF A01.

The summaries contain engineering, economic and environmental data about industrial facilities in various industries discharging pollutants in their wastewaters and considers whether the EPA should pursue regulations to control such discharges. The summaries were prepared in order to allow EPA to respond to the mandate of Section 304(m) of the Clean Water Act. Summaries for categories already subject to rulemaking were developed for comparison purposes, and contain only the minimum amount of data needed to provide some perspective on the relative magnitude of the pollution problems created across the categories. The purpose of this ongoing work is to develop information to characterize the solvent recycling industry as to the scope of the industry, its operations, and its discharges to the nation's waters, and to identify and quantity the pollutants discharged.

24442 (PB–90-126475/XAB) **Preliminary data summary for the paint-formulating point-source category.** Williams, D. Environmental Protection Agency, Washington, DC (USA). Office of Water Regulations and Standards. Sep 1989. 100p. (EPA–440/1-89/050). Available from NTIS, PC A05/MF A01.

The summaries contain data about industrial facilities in various industries discharging pollutants in their wastewaters and considers whether the EPA should pursue regulations to control such discharges. The summaries were prepared in order to allow EPA to respond to the mandate of Section 304(m) of the Clean Water Act. Summaries for categories already subject to rulemaking were developed for comparison purposes. The paint formulating industry is one of 12 industries identified in the DSS as a potential source of hazardous waste discharges to POTWs. The study gathered information to assist the Agency in deciding whether to develop national effluent limitations guidelines and standards for the industry. The document comprises three independent studies: a technical support study, an economic impact study, and an environmental impact study.

24443 (PB–90-126483/XAB) **Preliminary data summary for the transportation-equipment-cleaning industry.** Hund, F. Environmental Protection Agency, Washington, DC (USA). Office of Water Regulations and Standards. Sep 1989. 123p. (EPA–440/1-89/104). Available from NTIS, PC A06/MF A01.

The summaries contain engineering, economic and environmental data about industrial facilities in various industries discharging pollutants in their wastewaters and considers whether the EPA

should pursue regulations to control such discharges. The summaries were prepared in order to allow EPA to respond to the mandate of Section 304(m) of the Clean Water Act. Summaries for categories already subject to rulemaking were developed for comparison purposes, to provide some perspective on the relative magnitude of the pollution problems created across the categories. EPA conducted a preliminary study of the transportation equipment cleaning industry as a result of the evaluation of the findings from the Domestic Sewage Study (DSS). The DSS obtained technical information for use in determining if additional effluent limitation guidelines and standards need to be developed and published for this point source category, and provides a source of current information about priority and hazardous pollutant discharges from this industry for permit writers and publicly owned treatment works (POTWs) managers and operators.

24444 (PB–90-126491/XAB) **Preliminary data summary for the drum-reconditioning industry.** Anderson, D.; DiCianna, D. Environmental Protection Agency, Washington, DC (USA). Office of Water Regulations and Standards. Sep 1989. 131p. (EPA–440/1-89/101). Available from NTIS, PC A07/MF A01.

The summaries contain data about industrial facilities in various industries discharging pollutants in their wastewaters and considers whether the EPA should pursue regulations to control such discharges. The summaries were prepared in order to allow EPA to respond to the mandate of Section 304(m) of the Clean Water Act. Summaries for categories already subject to rulemaking were developed for comparison purposes. The study developed information to characterize the drum reconditioning industry as to the scope of the industry, its operation, its discharges to the Nation's waters, and identification and quantification of the pollutants.

24445 (PB–90-126517/XAB) **Preliminary data summary for the hazardous-waste-treatment industry.** DiCianna, D.; Yance, J.; Tarnay, A. Environmental Protection Agency, Washington, DC (USA). Office of Water Regulations and Standards. Sep 1989. 186p. (EPA–440/1-89/100). Available from NTIS, PC A09/MF A01.

The summaries contain data about industrial facilities in various industries discharging pollutants in their wastewaters and considers whether the EPA should pursue regulations to control such discharges. The summaries were prepared in order to allow EPA to respond to the mandate of Section 304(m) of the Clean Water Act. Summaries for categories already subject to rulemaking were developed for comparison purposes, and contain only the minimum amount of data needed to provide some perspective on the relative magnitude of the pollution problems created across the categories. The study developed information to characterize the hazardous waste treatment industry as to the scope of the industry, its operations, its discharges to the Nation's waters, and identification and quantification of the pollutants discharged.

24446 (PB–90-126525/XAB) **Preliminary data summary for the machinery manufacturing and rebuilding industry.** Rajvanshi, S.; Tudor, L.; Greene, A. Environmental Protection Agency, Washington, DC (USA). Office of Water Regulations and Standards. Oct 1989. 395p. (EPA–440/1-89/106). Available from NTIS, PC A17/MF A03.

The summaries contain data about industrial facilities in various industries discharging pollutants in their wastewaters and considers whether the EPA should pursue regulations to control such discharges. The summaries were prepared in order to allow EPA to respond to the mandate of Section 304(m) of the Clean Water Act. Summaries for categories already subject to rulemaking were developed for comparison purposes, and contain only the minimum amount of data needed to provide some perspective on the relative magnitude of the pollution problems created across the categories. The machinery manufacturing and rebuilding (MM&R) project prepared a preliminary data summary to assist the Agency in deciding whether to develop national effluent limitations guidelines and standards for MM&R facilities. The preliminary data summary includes two studies, a technical support study and an economic impact and cost effectiveness study.

24447 (PB–90-126533/XAB) **Preliminary data summary for the pharmaceutical-manufacturing point-source category.** Hund, F.; Brown, D. Environmental Protection Agency, Washington, DC (USA). Office of Water Regulations and Standards. Sep 1989. 236p. (EPA–440/1-89/084). Available from NTIS, PC A11/MF A02.

The summaries contain data about industrial facilities in various industries discharging pollutants in their wastewaters and considers whether the EPA should pursue regulations to control such discharges. The summaries were prepared in order to allow EPA to respond to the mandate of Section 304(m) of the Clean Water Act. Summaries for categories already subject to rulemaking were developed for comparison purposes, and contain only the minimum amount of data needed to provide some perspective on the relative magnitude of the pollution problems created across the categories. The study provides technical, economic, and environmental bases to determine whether additional effluent limitation guidelines and standards to control the discharge of toxic and hazardous pollutants are necessary for the pharmaceutical manufacturing industry and serves as a source of information to be used by permit writers and publicly owned treatment works (POTWs) in controlling hazardous wastes until final rules are published.

24448 (PB–90-126541/XAB) **Preliminary data summary for industrial laundries.** Hund, F. Environmental Protection Agency, Washington, DC (USA). Office of Water Regulations and Standards. Sep 1989. 200p. (EPA–440/1-89/103). Available from NTIS, PC A09/MF A02.

The summaries were prepared in order to allow EPA to respond to the mandate of Section 304(m) of the Clean Water Act. Summaries for categories already subject to rulemaking were developed for comparison purposes, and contain only the minimum amount of data needed to provide some perspective on the relative magnitude of the pollution problems created across the categories. The document provides the most current information available about the industrial laundries subcategory of the auto and other laundries point source category. Included are a technical support study including processes employed, waste characteristics, and wastewater treatment technologies employed; an economic impact study projecting the likely economic results of regulating industrial laundries wastewater discharge and an environmental impact study evaluating the impacts of the industry's wastewater on the environment.

24449 (PB–90-132457/XAB) **Species composition of fish communities in northern Wisconsin lakes: Relation to pH.** Hendrey, G.R.; Wiener, J.G.; Rago, P.J.; Eilers, J.M. National Fisheries Research Center, La Crosse, WI (USA). 1989. 18p. Available from NTIS, PC A03/MF A01.

Pub. in Early Biotic Responses to Advancing Lake Acidification, Woburn, MA., Chapter 8, Vol. 6, 133-146(1984).

Recent investigations of surface water and precipitation chemistry have aroused considerable concern about the potential effects of acidic precipitation on aquatic ecosystems in the north-central United States. The mean weighted pH of precipitation at two monitoring stations in north-central Wisconsin during 1980 was 4.45 and 4.63, or about 10-14 times more acidic than normal rainfall, which has a theoretical pH of 5.6. Many watersheds in northern Wisconsin have acid soils with low buffering capacity. Consequently, the water of most lakes in these watersheds is very soft and slightly acidic. Analyses of 275 northern Wisconsin lakes by Eilers et al. during 1979 indicated that 36% of the lakes were susceptible and an additional 50% were potentially susceptible to acidification from acid precipitation.

24450 (PB–90-132473/XAB) **US EPA (Environmental Protection Agency) perspective on AOC (assimilable organic carbon) research as related to coliform colonization and compliance problems.** Reasoner, D.J.; Rice, E.W. Environmental Protection Agency, Cincinnati, OH (USA). Drinking Water Research Div. c 1989. 17p. (EPA–600/D-89/267). Available from NTIS, PC A03/MF A01.

Pub. in Proceedings of the AWWA (American Water Works Association) Water Quality Technology Conference, Philadelphia, PA.(November 12-15, 1989).

The biological stability of treated drinking water has become a major concern for water utilities. The U.S. E.P.A. is concerned from the perspective of coliform MCL compliance and remediation of coliform biofilm problems. The levels of readily assimilable nutrients present in treated water are affected by water treatment processes, but of greatest concern are those processes, such as ozonation,

that cause increases in the levels of assimilable organic carbon (AOC) and therefore contribute to biological instability of the water. Thus, the combined use of ozonation (pre-oxidant) and a lower disinfectant residual as an approach to reducing disinfectant byproducts may result in increased bacterial growth, including coliforms, in the distribution system. Information is needed on: the AOC flux level that stimulate coliform growth in biofilm: the specific nutrients and concentrations that can stimulate growth of both coliforms and HPC; treatment strategies to reduce AOC levels and strategies to effectively control biofilm formation where AOC levels cannot be reduced.

24451 (PB–90-134362/XAB) **Application of a hazard assessment research strategy to the ocean disposal of a dredged material: Overview.** Gentile, J.H.; Pesch, G.G.; Dillon, T.M. Environmental Protection Agency, Narragansett, RI (USA). Environmental Research Lab. c 1989. 10p. (EPA–600/D-89/229). Available from NTIS, PC A02/MF A01.

Pub. in Oceanic Processes in Marine Pollution, Volume 5. Urban Wastes in Coastal Marine Environments, Chapter 11, 115-122.

Under the Marine Protection, Research and Sanctuaries Act the U.S. Environmental Protection Agency (EPA) has responsibility for establishing and applying criteria for reviewing and evaluating permits for dumping wastes into the ocean, and the U.S. Army Corps of Engineers (COE) has responsibility for issuing permits for the disposal of dredged material into the ocean. After several years of operational experience, the EPA and the COE have reexamined the strengths and weaknesses of the permit program and the general state of the art in sediment testing for the evaluation of the disposal of dredged material into the marine environment. The chapter describes a predictive hazard assessment strategy and decision rationale for disposal that can be used as the basis for revisions both in the ocean dumping regulations and in the permitting program.

24452 (PB–90-134388/XAB) **Hazard assessment research strategy for ocean disposal.** Gentile, J.H.; Bierman, V.J.; Paul, J.F.; Walker, H.A.; Miller, D.C. Environmental Protection Agency, Narragansett, RI (USA). Environmental Research Lab. 1989. 20p. (EPA–600/D-89/231). Available from NTIS, PC A03/MF A01.

Pub. in Ocean Processes in Marine Pollution, Volume 3. Marine Waste Management: Science and Policy, Chapter 16, 199-212(1989).

A decision rationale for ocean disposal based on a predictive hazard assessment research strategy is presented. The conceptual framework for hazard assessment is outlined, and its major components are identified and discussed. The strategy involves the synthesis of results from separate exposure and effects components in order to provide a scientific basis for estimating the probability (risk) of harm to the aquatic environment. The exposure assessment component consists of methodologies for determining biological effects as a function of contaminant exposure concentrations. Two case studies illustrate how a hazard assessment strategy synthesizes exposure and effects information to provide a casual linkage between mass inputs of contaminants and biological effects. The first study examines sewage-sludge disposal at Deepwater Dumpsite-106. The second study, which examines the disposal of dredged material in a shallow coastal site in central Long Island Sound, is a field verification program designed to test methodologies required for the acquisition of exposure and effects information. Both the laboratory and field data are synthesized to evaluate the accuracy and confidence of predictions of the individual methods, the tiered hierarchal concept, and the final prediction.

24453 (PB–90-134420/XAB) **Integrated approach to acid-rainfall assessments.** Schnoor, J.L.; Carmichael, G.R.; Van Schepen, F.A. Iowa Univ., Iowa City, IA (USA). Coll. of Engineering. c 1982. 22p. Available from NTIS, PC A03/MF A01.

Pub. in Energy and Environmental Chemistry, Chapter 13, Vol. 2, 225-243(1982). Library of Congress catalog card No. 81-69255.

A tiered approach to the mathematical modeling of acid precipitation, its fate and effects, might include: (1) a steady-state susceptibility model to assess long-term effects from average annual atmospheric loadings on surface and groundwaters; (2) a dynamic, regional model to assess the role of long-range versus point-source pollutant loadings for regulatory purposes and (3) a three-dimensional dynamic event model to assess the maximum environmental insult to a specific ecosystem during critical conditions such as a snow-melt event. An integrated approach is needed which considers the fate of pollutants from their origin through terrestrial and aquatic ecosystems to the ultimate water resource, groundwater.

24454 (PB–90-134438/XAB) **Concern for acidic deposition in the Great Lakes region.** Loucks, O.L. Institute of Ecology, Indianapolis, IN (USA). c 1982. 24p. Available from NTIS, PC A03/MF A01.

Pub. in Acid Precipitation: Effects on the Ecological Systems, Chapter 2, 21-41(1982). Library of Congress catalog card no. 81-69072.

The Great Lakes region of the United States and Canada is an especially appropriate focus for a conference on acid rain in 1981 for one paramount reason: If the evidence is compelling that environmental alterations from acidic deposition could, indeed, be of the type and magnitude being alleged in other regions, then there are urgent decisions and actions needed now to prevent those effects from being expressed here. A principal conference goal, therefore, must be to review the evidence as it applies to the unaltered, or slightly altered, Great Lakes region, and to consider what new data or relationships still need documentation before mitigation or control strategies can be evaluated.

24455 (PB–90-134446/XAB) **Effects of complex effluents on photosynthesis in Lake Erie and Lake Huron.** Bridgham, S.D.; McNaught, D.C.; Meadows, C. Duke Univ., Durham, NC (USA). School of Forestry and Environmental Studies. c 1988. 15p. Available from NTIS, PC A03/MF A01.

Pub. in Functional Testing of Aquatic Biota for Estimating Hazards of Chemicals, ASTM STP 988, 74-85(1988).

Phytoplankton are the base of the food chain in most large lake ecosystems; if affected by environmental pollutants, significant ecosystem changes can result with potential impact on higher trophic levels. The research determined the effects of a complex effluent discharge from the River Raisin in Monroe County, Michigan, on the Lake Erie ecosystem. The river flows through southern Michigan and has large nutrient and industrial inputs, especially in the Monroe Harbor area. The functional parameters measured were bacterial uptake rate of acetate, zooplankton feeding and reproduction rates, and primary production. The results of the effects of complex effluents on gross photosynthesis, measured as carbon-14 ((14)C) uptake, are presented in the paper.

24456 (PB–90-134453/XAB) **Effects of complex effluents from the River Raisin on zooplankton grazing in Lake Erie.** McNaught, D.C.; Bridgham, S.D.; Meadows, C. Minnesota Univ., Minneapolis, MN (USA). Dept. of Ecology and Behavioral Biology. c 1988. 13p. Available from NTIS, PC A03/MF A01.

Pub. in Functional Testing of Aquatic Biota for Estimating Hazards of Chemicals, ASTM STP 988, 128-137(1988).

Functional ecosystem tests should reflect the hazards of toxic chemicals, as well as stimulation by nutrients, by measuring a single flux of phytoplankton to the dominant members of the community. The flux of phytoplankton and detritus to zooplankton is reflected by the filtering rates of individual organisms, expressed as millilitres per animal per hour. The authors used common particle counting techniques to measure such fluxes in the waters of Lake Erie. They then examined the impact of complex effluents on the filtering rates. These effluent effects are scored as inhibition or stimulation of filtering by the dominant herbivores in the Lake Erie ecosystem. In the River Raisin, a tributary to Lake Erie, specific effluents usually inhibited grazing by the herbivores Daphnia. Diaptomus, and Cyclops, although one effluent was stimulatory. These results were directionally consistent and probably depended on the characteristics (especially the concentrations of metals) of the effluents.

24457 (PB–90-134479/XAB) **Intrauterine exposure to environmental toxins: The significance of subtle behavioral effects.** Jacobson, J.L.; Jacobson, S.W.; Fein, G.G. Wayne State Univ., Detroit, MI (USA). c 1985. 16p. Available from NTIS, PC A03/MF A01.

Pub. in Beyond the Individual Environmental Stressors, 125-137(1985).

Recently, there has been an increase in interest in subtle effects associated with exposure to environmental toxins. One methodological problem in research in this area involves assessment of degree of contamination when exposure occurs at low and moderate levels. A second problem lies in determining the clinical or practical significance of subtle toxic effects when they are observed. Both these issues are illustrated by the case of polychlorinated biphenyls (PCBs), a family of environmental toxins found in moderate concentrations in humans who consume Lake Michigan sports fish.

24458 (PB–90-135971/XAB) **Health assessment for Beacon Heights Landfill National Priorities List (NPL) Site, Beacon Falls, Connecticut, Region 1. CERCLIS No. CTD001145671. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 26 Jan 1989. 18p. Available from NTIS, PC A03/MF A01.

The Beacon Heights Landfill National Priorities List (NPL) Site is located in Beacon Falls, Connecticut. From the 1920's to 1979, municipal and industrial wastes were disposed of at the landfill. Leachate from the landfill has migrated into the local groundwater aquifers. Two residential wells to the northwest of the site have been contaminated with site-related contaminants. This site is of potential public health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects. Human exposure to benzene, chlorobenzene, chloroethane, and methylene chloride may have occurred via ingestion, inhalation, and direct dermal contact with contaminated groundwater. No health study follow-up is indicated at this time.

24459 (PB–90-135989/XAB) **Health assessment for Kellogg-Deering Site, Norwalk, Connecticut, Region 1. CERCLIS No. CTD980670314. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 23 Oct 1986. 10p. Available from NTIS, PC A02/MF A01.

The 10-acre well field is located on the west bank of the Norwalk River. In 1975, trichloroethene was detected in one of the production wells. The maximum concentration detected was 600 ug/1 in 1980. The most recent sampling reported a maximum concentration of 86 ug/1. Air stripping is an acceptable method to mitigate the potentially significant public health threat posed to the community by the contaminated groundwater.

24460 (PB–90-135997/XAB) **Health assessment for Laurel Park Landfill, Naugatuck, Connecticut, Region 1. CERCLIS No. CTD980521165. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 4 Dec 1986. 14p. Available from NTIS, PC A03/MF A01.

The Environmental Protection Agency, Region I, submitted the Endangerment Assessment Report and Remedial Investigation Report for the Laurel Park Landfill, a National Priority List site, to the Agency for Toxic Substances and Disease Registry for review. Based on the information provided, additional monitoring data is needed to determine the extent and degree of contamination in order to properly assess endangerment of public health. However, the current maximum contaminant levels found in on-site soil and leachate (i.e., arsenic, chromium, 1,2-dichloroethane, benzene, 1,2-dichloroethylene, n-nitrosodiphenylamine, 2,4-dichlorophenol) pose a potential public health threat. Therefore, public access to the contaminated areas should be restricted.

24461 (PB–90-136003/XAB) **Health assessment for Nutmeg Valley, Wolcott, Connecticut, Region 1. CERCLIS No. CTSI88045. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 2 May 1988. 8p. Available from NTIS, PC A02/MF A01.

The Nutmeg Valley Industrial Park is listed on the National Priorities List. The site is an industrial park containing 40 companies (light industry metal working and finishing) and 20 private residences. The contaminants present in groundwater at the site are trichloroethylene, benzene, ethyl benzene, toluene, xylene, methylene chloride, trans 1,2-dichloroethane, 1,1,1-trichloroethane, tetrachloroethylene, pentane, carbon tetrachloride, and chloroform. Investigation into the extent of contamination in other pathways is ongoing.

24462 (PB–90-136011/XAB) **Health assessment for Old Southington Landfill, Southington, Hartford County, Connecticut, Region 1. CERCLIS No. CTD980670806. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 20 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

The Old Southington Landfill (OSL) is listed by the U.S. Environmental Protection Agency on the National Priorities List. The 10-acre site was formerly a municipal landfill from 1947 to 1967. Preliminary on-site sampling results have identified various volatile organic compounds (VOC's). However, the most recent sampling information reported occurred in January 1984. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances. Information on this site is not currently adequate to rule out the possibility of potential health effects from the ingestion and inhalation of, and direct contact with contaminated soil, groundwater, surface water, and the other exposure pathways discussed. Additional information on contaminants released, populations potentially exposed, and environmental pathways through which the contaminants can reach these populations is necessary to assess the potential health concerns regarding this site.

24463 (PB–90-136037/XAB) **Health assessment for Solvents Recovery Services of New England, Southington, Hartford County, Connecticut, Region 1. CERCLIS No. CTD009717604. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 15 Dec 1988. 15p. Available from NTIS, PC A03/MF A01.

The Solvents Recovery Services of New England site is listed by the U.S. Environmental Protection Agency (EPA) on the National Priorities List (NPL). The facility receives various industrial solvents which are distilled for reuse or blended for use as a fuel product. Exact contaminant concentrations for VOCs in on-site and off-site ground water were not provided. Contaminants found were isopropyl alcohol, methyl ethyl ketone (MEK), acetone, tetrahydrofuran, methyl isobutyl ketone, methylene chloride, toluene, 1,1-dichloroethane, 1,1,1-trichloroethane, 1,2-trans-dichloroethene, ethylbenzene, trichloroethene were detected between 1,000-10,000 ppb; 1,2-dichloroethane, 1,1-dichloroethene, and tetrachloroethene were detected at less than 1,000 ppb. Some compounds frequently exceeded 10,000 ppb, with others exceeding 100,000 ppb, on a less frequent basis, in ground water underlying and near the SRSNE facility. In addition, a non-aqueous phase liquid (NAPL) plume may be present. Lead (905 ppm), cadmium (331 ppm), and polychlorinated biphenyls (PCBs) (maximum Arochor-1260 at 110 ppm) were found in on-site surface soils. Trichloroethene (120 ppm), methylene chloride (580 ppm), vinyl chloride (2 ppm) and tetrachloroethene (820 ppm) were found in the on-site subsurface soils (1-6 feet). The site is of potential public health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects. Human exposure to VOCs, heavy metals, PCBs, and other unidentified site-related contamination may occur, may have occurred, or may be occurring via either ingestion, dermal, or inhalation exposure to sediments, surface water, ground water, consumable biota, or air.

24464 (PB–90-136052/XAB) **Health assessment for Baird and McGuire, Holbrook, Massachusetts, Region 1. CERCLIS No. MAD001041987. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 29 Oct 1985. 12p. Available from NTIS, PC A03/MF A01.

The Baird & McGuire site in Holbrook, Massachusetts was evaluated for potential health effects of the herbicide, pesticide, and dioxin concentrations found there. There is concern that the contaminants enter the river and may eventually contaminate the towns' water supply. Groundwater contamination and surface runoff into the river are the pathways of concern. To a lesser extent, air dispersion of contaminated surface materials off site is another potential pathway. The sampling data demonstrates that surface and subsurface soil is heavily contaminated with organochlorine and dioxin compounds. The levels of soil contaminants represent a potential public health hazard to nearby residents. Off site migration can occur via groundwater contamination and/or surface runoff to the river and subsequent ingestion of water, fish, shellfish and

other benthic organisms. Moreover, air can be a pathway but it is unlikely due to the low vapor pressure of the compounds which are adsorbed to the soil.

24465 (PB–90-136060/XAB) **Health assessment for Yaworski Lagoon, Town of Canterbury, Windham County, Connecticut, Region 1. CERCLIS No. CTD009774969. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 5 Apr 1988. 19p. Available from NTIS, PC A03/MF A01.

The Yaworski NPL site is situated in a meander loop and floodplain of the Quinebaug River in Windham county in the Town of Canterbury, Connecticut. The site groundwater is heavily contaminated with volatile organic compounds and heavy metals and is unfit for human consumption. At the present, there does not appear to be any potential human exposure to the contaminated groundwater due to groundwater flow conditions, and the site is not likely to be developed. EPA target clean-up levels were proposed for consumptive use of the groundwater by the public if the site were developed. The primary potential exposure pathway is ingestion of contaminated groundwater if the aquifer around the site is developed.

24466 (PB–90-136078/XAB) **Health assessment for Charles George Landfill, Tyngsboro, Massachusetts, Region 1. CERCLIS No. MAD003809266. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 18 Mar 1987. 11p. Available from NTIS, PC A03/MF A01.

In Tyngsboro, Massachusetts the Charles George Landfill contaminants (benzene, toluene, trichloroethylene, polynuclear aromatic hydrocarbons, 2-butanone, chloroform, copper, arsenic, and cadmium) present a potential public health hazard from ingestion and other contact with groundwater, surface water, soil, and sediments. Remedial actions currently in place (landfill cap, leachate collection system, gas vent collection system, access restrictions) deal, probably effectively, with the stabilization of on-site contamination. Future remedial investigations (RI) will explore further the extent of off-site migration of contaminants, and suitable technologies to treat the problem.

24467 (PB–90-136086/XAB) **Health assessment for Groveland Wells, Groveland, Massachusetts, Region 1. CERCLIS No. MAD980732317. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 6 Aug 1985. 14p. Available from NTIS, PC A03/MF A01.

The Groveland Wells Site includes three separate hazardous waste sites: A.W. Chesterton Company (70 acres), Valley Manufactured Products Company, Inc. (1.6 acres), and the former Haverhill Municipal Landfill (75 acres). Extensive multimedia sampling of the Groveland Wells Site revealed numerous contaminants, the more prevalent being volatile organic compounds. The principal contaminants included: trichloroethylene, tetrachloroethene, 1,1,1-trichloroethane, and trans-1,2-dichloroethene. Although some contamination of surface waters and soils was evident, of primary concern is contamination of areal groundwaters which in the past supplied drinking water for the township. Closure of the supply wells in 1979 mitigated the primary exposure pathway, ingestion of contaminated groundwaters. Present, potential exposure appears to be limited to incidental ingestion of contaminated surface water during recreational contact. In order to mitigate future, chronic exposure to groundwater contaminants, insure Groveland's drinking water supply either originates from an uncontaminated source or is adequately treated to remove deleterious substances.

24468 (PB–90-136094/XAB) **Health assessment for Haverhill Municipal Landfill, Haverhill, Massachusetts, Region 1. CERCLIS No. MAD980523336. Preliminary report.** Massachusetts Dept. of Public Health, Boston, MA (USA). 4 Nov 1988. 10p. Available from NTIS, PC A02/MF A01.

The Haverhill municipal landfill site has been listed by the U.S. Environmental Protection Agency (EPA) on the National Priorities List (NPL) as of 1984. The site has operated as an industrial landfill since the late 1930's or early 1940's by Trimount Bituminous Products (TBP). It is suspected that the site started to accept municipal wastes in the 1960's. Elevated levels of benzene, trichloroethylene, methylene chloride, and vinyl chloride were detected in samples drawn from ground water monitoring wells drilled on the landfill site. Arsenic, lead, mercury, manganese and chromium were also detected in on-site ground water. Benzo(a)anthracene was found in a composite soil sample taken at depths of four, fifteen and twenty feet below land surface (bls) on the property. Volatile organic compounds (VOC's) found in ground water were also detected in this soil sample. Dibenzofuran was detected in a soil sample taken at 44 feet bls. Surface water had arsenic, high levels of chromium, lead and cadmium. Trichloroethylene (TCE) was detected here. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances. This exposure could occur via ingestion of TCE, vinyl chloride and heavy metal contaminated ground water caused by the leaching of these compounds from materials deposited at the landfill.

24469 (PB–90-136110/XAB) **Health assessment for Industriplex 128, Woburn, Massachusetts, Region 1. CERCLIS No. MAD076580950. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 17 Mar 1986. 15p. Available from NTIS, PC A03/MF A01.

Heavy metal soil contamination at the Industriplex 128 site, a manufacturing site for more than 100 years, was discovered. Buried wastes from previous manufacturing activities have been excavated and piled in open areas on the site. The primary contaminants reported in surface soil samples are: arsenic, chromium, copper, and lead. The maximum reported value for arsenic (6040 ppm) slightly exceeds the maximum acceptable site surface soil value but it is insufficient evidence to necessitate a cleanup. Because of the limited surface sampling, additional samples should be analyzed. The maximum concentrations of arsenic and copper reported in surface soil might be toxic to vegetation which would pose a problem in attempting to control erosion. Off-site migration of the benzene and toluene groundwater contamination has been identified and should be cleaned up.

24470 (PB–90-136128/XAB) **Health assesament for Iron Horse Park, Billerica, Massachusetts, Region 1. CERCLIS No. MAD051787323. Final report.** Massachusetts Dept. of Public Health, Boston, MA (USA). 5 Dec 1988. 29p. Available from NTIS, PC A03/MF A01.

Iron Horse Park (IHP) contains different industrial operations where numerous sources of groundwater, surface water and soil contamination have been identified. On-site contaminants include Methylene chloride, Benzene, Benzidine, 1,1,Dichloroethene, 1,2 Trans-Dichloroethene, 1,2 Dichloroethane, 1,1,1 Trichloroethane, Trichloroethene, Tetrachloroethene, Benz(a)anthracene, Benzo(b)flouranthene, Benzo(k)flouranthene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, Indeno (1,2,3-cd)pyrene, Arochlor 1242, Arsenic, Cyanide, Lead, Selenium, and Asbestos. The site is of public health concern because of the risk to human health resulting from exposure to hazardous substances at concentrations that may result in adverse health effects. Human exposure to asbestos may have occurred in the past via inhalation of fugitive asbestos dusts in either indoor or ambient air. In addition, soil lead levels that were detected near the B & M locomotive garage also constitute a health concern. Potentially dangerous levels of benzene and arsenic and benzidine levels could also be a public health threat. PAH's, are found in the pond at levels approaching their solubility limits. Elevated levels of arsenic were also found in Richardson Pond. Data must be obtained in order to assess the degree of contamination in resident fish, other aquatic organisms, vegetation and fowl. The soil near the Johns-Manville catch basins and the sediments in the Middlesex Canal near the J-M plant contain excessive amounts of carcinogenic PAH's and PCB's. B & M waste water lagoons contain high levels of PAH's and some have also contained detectable amounts of asbestos. B & M Garage had levels of lead that pose a threat to the workers near the garage. B & M scrap yards had high levels of asbestos in soils at the scrap yard.

24471 (PB–90-136151/XAB) **Health assessment for Plymouth Harbor/Cannon Engineering Corporation, Plymouth, ,assachusetts, Region 1. CERCLIS No. MAD980525232. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 1990. 17p. Available from NTIS, PC A03/MF A01.

The Cannon Engineering Corporation Plymouth (CEC Plymouth) National Priorities List (NPL) Site is located adjacent to Plymouth Harbor about one and one-half miles northwest of the Town of Plymouth and one and one-half miles southeast of the Towns of Kingston and Kingston Shores, Massachusetts. The site facilities consisted of three storage tanks, two of which were used to store hazardous wastes before disposal. Past remedial measures included the removal and disposal of the tanks and tank contents, and other miscellaneous wastes present at the site. Low concentrations of pesticides were found in on-site groundwater samples. The primary on-site soil contaminants are polynuclear aromatic hydrocarbons (PAHs), pesticides, and heavy metals. The human exposure pathways of major concern are the ingestion and dermal absorption of contaminants in on-site soil. Long-term exposure to the contaminated on-site soils poses a potential human health threat.

24472 (PB-90-136177/XAB) **Health assessment for ReSolve, Inc., Dartmouth, Massachusetts, Region 1. CERCLIS No. MAD980520621. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 3 Jun 1987. 12p. Available from NTIS, PC A03/MF A01.

The Environmental Protection Agency Region I Office requested that the Agency for Toxic Substances and Disease Registry review and comment on the Remedial Investigation for the ReSolve site. Based on the information presented, a potential public health threat exists for persons who may contact or ingest surface soils contaminated with polychlorinated biphenyls (PCBs) and volatile organic compounds (VOCs) and/or contact surface water and groundwater contaminated with PCBs and VOCs. Additionally, there is concern that the PCBs present in the sediments of surface water could make their way into the food chain. Since the unlined lagoons at the site were used for burning volatile organics and PCBs, the possible presence and concentrations of chlorinated dibenzo-p-dioxin (CDD) and chlorinated dibenzofuran (CDF) congeners should be determined.

24473 (PB-90-136193/XAB) **Health assessment for Salem Acres, Essex County, Salem, Massachusetts, Region 1. CERCLIS No. MAD980525240. Preliminary report.** Massachusetts Dept. of Public Health, Boston, MA (USA). 10 Mar 1989. 8p. Available from NTIS, PC A02/MF A01.

The Salem Acres, Incorporated site is a 235 acre parcel located in Salem, Essex County, Massachusetts. There are pits at the site which have apparently been filled with sewage sludge and tannery wastes. Organic compounds and metals have been found in the sludge in the pits, generally in the high parts-per-million range in very limited testing. Compounds detected in sludge included PCB-1254, lead, chromium, and mercury. Soil samples in the area did not show evident contamination. Off-site surface water had elevated levels of lead; two measurements were 64 ug/l and 89 ug/l, approximately. An oil sheen in surface water and vegetation typical of polluted areas indicated water quality degradation. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via continued direct exposure to soils, sediments and sludge residues in marginal areas of the site, and any consumption of any fish from the streams draining the site.

24474 (PB-90-136219/XAB) **Health assessment for Coakley Landfill, North Hampton, New Hampshire, Region 1. CERCLIS No. NHD064424153. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 13 Oct 1988. 15p. Available from NTIS, PC A03/MF A01.

The Coakley Landfill, which is located near North Hampton, New Hampshire, was in operation from early 1972 until 1985. Waste materials disposed at the landfill included municipal wastes, industrial wastes, sewage sludge, and incinerator residue from the Incinerator Recovery Plant at the Pease Air Force Base. Several small businesses, cluster homes, and single family residences are located near the site. In 1983, several private, potable water wells near the site were found to be contaminated with volatile organic chemicals (VOCs). The concentrations of VOCs detected in private wells have generally been below a level that would be expected to cause adverse health effects. However, in some wells, benzene concentrations in excess of acceptable drinking water concentrations were detected. VOC contamination has been detected in ground water, leachate, and ambient air from the landfill and sediment samples from some nearby streams. The concentrations of VOCs detected in these media would not be expected to have a significant impact on public health. VOCs detected included: Arsenic, Benzene, Chromium, Chloroethane, Tetrahydrofuran, Lead, Methyl ethyl ketone, 1,1-Dichloroethane, 1,1,1-Trichloroethane, Toluene, Benzene, Ethyl benzene, Xylenes, Methyl ethyl ketone, Methyl isobutyl ketone, Diethyl ether, Acetone, Phenanthrene, Benzo(a)pyrene, TCE, and Trichloromethane.

24475 (PB-90-136227/XAB) **Health assessment for Dover Municipal Landfill, Stratford County, Dover, New Hampshire, Region 1. CERCLIS No. NHD980520191. Final report.** New Hampshire Dept. of Health and Human Services, Concord, NH (USA). Environmental Health Risk Assessment Unit. 12 Apr 1989. 27p. Available from NTIS, PC A03/MF A01.

The Dover Municipal Landfill is an inactive landfill located on Tolend Road in the western corner of Dover, New Hampshire. Specific wastes include municipal trash, leather tanning wastes, industrial solvents, and municipal wastewater treatment plant sludge. Contamination at the landfill exists in on-site groundwater, leachate, sediments, and soil. The Dover Municipal Landfill site is of potential public health concern due the potential risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects.

24476 (PB-90-136235/XAB) **Health assessment for Auburn Road Landfill, Rockingham County, Londonderry, New Hampshire, Region 1. CERCLIS No. NHD980524086. Final report.** New Hampshire Dept. of Health and Human Services, Concord, NH (USA). Environmental Health Risk Assessment Unit. 11 Apr 1989. 42p. Available from NTIS, PC A03/MF A01.

The Auburn Road Landfill National Priorities List (NPL) site is located in a residential area of the town of Londonderry, New Hampshire. Soils at four areas of the site are heavily contaminated with volatile organic compounds (VOCs), polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), semi-volatile organic compounds (SVOCs), pesticides, and inorganic compounds. Contaminants, including VOCs, PAHs, SVOCs, and inorganics, have migrated to groundwater on-site and off-site. The levels detected in the contaminant plumes render the water unfit for human consumption. The Auburn Road Landfill Site is of potential public health concern because of the potential risk to human health resulting from possible past and future exposures to hazardous substances at concentrations that may result in adverse health effects.

24477 (PB-90-136243/XAB) **Health assessment for Winthrop Landfill, Winthrop, Maine, Region 1. CERCLIS No. MED980504435. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 15 Sep 1983. 6p. Available from NTIS, PC A02/MF A01.

The Winthrop Landfill, originally a series of gravel pits, later a municipal dump and finally a landfill, received organic chemical wastes from the early 1950's to the mid-1970's. An unknown volume of chemical wastes is thought to have been buried at the northeastern tip and near the west-central edge of the landfill in the mid-1970's. The authors recommend conducting quarterly groundwater monitoring to protect the residents from consuming contaminated water as the plume spreads through the area groundwater.

24478 (PB-90-136250/XAB) **Health assessment for Union Chemical, South Hope, Maine, Region 1. CERCLIS No. MED042143883. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 2 Sep 1988. 43p. Available from NTIS, PC A03/MF A01.

Union Chemical is a proposed National Priorities List (NPL) site situated one-quarter mile west of South Hope, Knox County, Maine. On-site soils, ground water and adjacent surface water (i.e., Quiggle Brook) appear to be contaminated with elevated levels of a variety of volatile organic compounds (VOC's) such as 1,1- and 1,2-dichloroethane, 1,1,1-trichloroethane, trichloroethylene, etc. The

site is of a potential health concern because exposure to hazardous substances at concentrations that may result in adverse health effects may have occurred in the past, and may occur in the future if the site is not remediated.

24479 (PB–90-136268/XAB) **Health assessment for Saco Tannery Waste Pits Site, Saco, York County, Maine, Region 1. CERCLIS No. MED980520241. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 31 Jan 1989. 12p. Available from NTIS, PC A03/MF A01.

The Saco Tannery Waste Pits Site is located in Saco, York County, Maine. Between 1959 and the early 1980's, chromium sludge, acid wastes, and other caustic wastes were dumped into two lagoons and 53 shallow, excavated pits at the site. Other wastes deposited at the site include methylene chloride, other spent solvents, and solid waste in the form of leather shavings. The environmental pathways of current concern at the site are the on-site sediment and sludge. Contaminated sludge and waste material in the pits and lagoons are the sources of low level organic contamination in the groundwater. The site is of potential public health concern because a risk to human health exists from possible exposure to hazardous substances at concentrations that may result in adverse human health effects. Human exposure to various contaminants may occur or be occurring primarily via incidental ingestion of and dermal contact with contaminated sediment.

24480 (PB–90-137043/XAB) **Comparison of occurrence and rates of chemical biodegradation in natural waters.** Vaishnav, D.D.; Babeu, L. Wisconsin Univ., Superior, WI (USA). Center for Lake Superior Environmental Studies. c 1987. 10p. Available from NTIS, PC A02/MF A01.

Pub. in Bulletin of Environmental Contamination and Toxicology, Vol. 39, 237-244(1987).

Anthropogenic materials can enter natural waters through domestic and industrial effluents, agricultural run-off, seepages from surface and sub-surface chemical repositories, atmospheric deposition, and accidental spills. An assessment of the biological effects of chemicals in aquatic environments requires an understanding of the fate of such xenobiotic compounds. Biodegradation may be a principal mechanism which dictates the longevity of chemical pollutants in terrestrial and aquatic environments (Bollag 1974). However, it is the environment that actually controls the biodegradation process and has a greater influence on the process than the microorganisms per se (Kaplan 1979). The present study was conducted to measure and compare the degradation of ten organic chemicals in ground, Lester River and Lake Superior harbor waters by autochthonous microorganisms.

24481 (PB–90-137068/XAB) **Fate and transport of sediment-associated contaminants, 1989.** Medine, A.J.; McCutcheon, S.C. Environmental Protection Agency, Athens, GA (USA). Environmental Research Lab. c 1989. 38p. (EPA–600/D-89/269). Available from NTIS, PC A03/MF A01.

Pub. in Hazard Assessment of Chemicals, Vol. 6, 225-291(1989). See also PB–88-139944.

Although sediments generally are considered to provide beneficial effects in terms of water quality movement through the sorption of pollutants from the water column, contaminated sediments also may result in adverse effects. The interactions of both metals and organic contaminants with suspended and bed sediments significantly affects the transport and transformation of these pollutants in streams and lakes. Information about these interactions is important in assessing hazards of pollutant exposure in freshwater systems. In the paper, research into the fate and transport of sediment-associated contaminants is reviewed. An overview of contaminant modeling is provided along with model descriptions of chemical and biological transformation processes. Research on the physical movement of contaminated sediment is presented, including near bed sediment transport and advective-dispersive transport in the water column.

24482 (PB–90-137316/XAB) **Nature and extent of ecological risks at Superfund sites and RCRA (Resource Conservation and Recovery Act) facilities (executive summary included).** Zamuda, C. Environmental Protection Agency, Washington, DC (USA). Office of Policy, Planning and Evaluation. Jun 1989. 219p. (EPA–230/03-89/043). Available from NTIS, PC A10/MF A02.

The Office of Policy Analysis within EPA has been conducting a study of the ecological risks posed by Superfund Sites and RCRA Facilities. In June 1989, OPA completed the first phase of the study and the report presents the results of OPA's efforts to characterize the nature and extent of ecological risks at Superfund sites and RCRA facilities. The report is divided into two main parts: Part I addresses Superfund sites and Part II addresses RCRA facilities.

24483 (PB–90-137324/XAB) **Ecological risk assessment methods: A review and evaluation of past practices in the Superfund and RCRA (Resource Conservation and Recovery Act) programs (executive summary included).** Zamuda, C. Environmental Protection Agency, Washington, DC (USA). Office of Policy, Planning and Evaluation. Jun 1989. 210p. (EPA–230/03-89/044). Available from NTIS, PC A10/MF A02.

Substances released from sites subject to the Comprehensive Environmental Response, Compensation, and Liability Act and the Resource Conservation and Recovery Act have the potential to cause adverse effects to human health and the environment. Although there are numerous examples of adverse ecological impacts being caused by releases of hazardous substances and wastes, programs have focused primarily on identification, analysis, and mitigation of potential adverse effects to human health. As a consequence of the program emphasis, relatively little information is available concerning the overall extent of ecological impacts at sites. EPA/OPA initiated a study of the nature and extent of ecological impacts at CERCLA and RCRA sites re. the methods that have been or could be used to evaluate ecological impacts at these sites, and past ecological risk management decisions and issues at OSWER waste sites.

24484 (PB–90-137332/XAB) **Ecological risk management in the Superfund and RCRA (Resource Conservation and Recovery Act) programs.** Zamuda, C. Environmental Protection Agency, Washington, DC (USA). Office of Policy, Planning and Evaluation. Jun 1989. 45p. (EPA–230/03-89/045). Available from NTIS, PC A03/MF A01.

The report discusses the extent to which ecological concerns have been used as a basis for decision making in the CERCLA and RCRA programs. For each program, the report first identifies areas in which ecological impacts could be considered, and then examines the manner and extent to which ecological concerns have, in fact, been taken into account in program activities. The report concludes with discussion of the major ecological risk management issues that should be addressed by the Agency if ecological concerns are to be fully considered in the RCRA/CERCLA decision making.

24485 (PB–90-137340/XAB) **Summary of ecological risks, assessment methods, and risk-management decisions in Superfund and RCRA (Resource Conservation and Recovery Act).** Zamuda, C. Environmental Protection Agency, Washington, DC (USA). Office of Policy, Planning and Evaluation. Jun 1989. 45p. (EPA–230/03-89/046). Available from NTIS, PC A03/MF A01.

In developing and implementing programs under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), EPA has focused primarily on analysis and mitigation of human health risks and less emphasis has been placed on analysis and mitigation of ecological threats at Superfund sites. As an initial step in investigating issues related to ecological threats at Superfund sites, EPA's Office of Policy Analysis has conducted a study of three broad topics: (1) the nature and extent of ecological threats at Superfund sites: (2) the ecological assessment methods that have been used in the Superfund program: and (3) the extent to which ecological concerns have been used as a basis for decision making at Superfund sites.

24486 (PB–90-137795/XAB) **Health assessment for Mottolo Hazardous Waste Site, Raymond, New Hampshire, Region 1. CERCLIS No. NHD980503361. Preliminary report.** New Hampshire Dept. of Health and Human Services, Concord, NH (USA). Environmental Health Risk Assessment Unit. 12 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

The Mottolo Hazardous Waste Site is listed on the U.S. Environmental Protection Agency's (EPA) National Priorities List (NPL). The site consists of a 10 acre portion of a 50 acre parcel of land formerly used for a piggery. Volatile organic chemicals (VOCs) are the only hazardous chemicals identified at the Mottolo Site. Groundwater and surface water have been the only media sampled. Groundwater analysis for inorganic compounds detected onsite concentrations of iron and manganese exceeding Secondary Maximum Contaminant Levels. Groundwater on-site has contained up to 8 ppm of total VOCs. Both the overburden and bedrock aquifers have been contaminated. Specific contaminants detected in groundwater were benzene, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethylene, 1,2-dichloroethylene, tetrahydrofuran, 1,1,1-trichloroethane, trichloroethylene, toluene, and xylenes. The site is considered to be of potential public health concern due to the risk to human health caused by the possibility of exposure to hazardous substances via contaminated groundwater, surface water, and soil. There appear to be no sources of acute health risks at the Mottolo Site. However, potential chronic health risks may be associated with contaminated groundwater, surface water, and potentially contaminated soils. A continual monitoring program of residential wells in the area is recommended until the source of contamination is mitigated or an alternate water source is provided.

24487 (PB–90-137803/XAB) **Health assessment for Ottati and Goss/Great Lakes Container Corporation NPL (National Priorities List) Site, Kingston, New Hampshire, Region 1. CERCLIS No. NHD990717647. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 16p. Available from NTIS, PC A03/MF A01.

The Ottati & Goss/Great Lakes Container Corporation National Priorities List (NPL) Site is located off Route 125 in Kingston, New Hampshire. Drum reconditioning and waste processing was conducted at the site from the late 1950's through July 1980. Waste material and drums were disposed of on site. Volatile organic compounds (VOCs), polychlorinated biphenyls (PCBs), and heavy metals were shown to be in on-site soils, groundwater, surface water, and sediment. VOCs and heavy metals were also shown to be in off-site groundwater and surface water. Samples from local residential potable water supply wells showed no contamination of public health concern. The site is of potential public health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects. Human exposure to VOCs, PCBs, and heavy metals may occur in the future if this site is not effectively remediated.

24488 (PB–90-137811/XAB) **Health assessment for Savage Municipal Well, Milford, Hillsborough County, New Hampshire, Region 1. CERCLIS No. NHD980671002. Preliminary report.** New Hampshire Dept. of Health and Human Services, Concord, NH (USA). Environmental Health Risk Assessment Unit. 10 Apr 1989. 10p. Available from NTIS, PC A02/MF A01.

The Savage Municipal Well Site is on the National Priorities List (NPL). Groundwater, surface water, and soil have been analyzed for VOCs and acid and base/neutral extrable compounds (ABNs). Specific contaminants included tetrachloroethylene, trans-1,2-dichloroethylene, trichloroethylene, vinyl chloride, and bis(2-ethylhexyl)phthalate. Lead, chromium, and mercury were detected in groundwater samples from wells below the surface discharge stream. Further environmental characterization and sampling of the site and impacted off-site areas during the Remedial Investigation and Feasibility Study (RI/FS) should be designed to address the environmental and human exposure pathways.

24489 (PB–90-137829/XAB) **Health assessment for Somersworth Municipal Landfill Site, Strafford County, Somersworth, New Hampshire, Region 1. CERCLIS No. NHD980520225. Final report.** New Hampshire Dept. of Health and Human Services, Concord, NH (USA). Environmental Health Risk Assessment Unit. 12 Apr 1989. 24p. Available from NTIS, PC A03/MF A01.

The Somersworth Municipal Landfill National Priorities List (NPL) Site is located in a predominantly residential part of central Somersworth, New Hampshire, approximately one mile southwest of downtown Somersworth. On-site soils are contaminated with low levels of volatile organic compounds (VOCs), metals and polycyclic aromatic hydrocarbons (PAHs). Groundwater beneath the site is contaminated with low levels of VOCs. The Agency for Toxic Substances and Disease Registry (ATSDR) has concluded that the Somersworth Landfill Site is of potential public health concern under current conditions because of the potential risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects.

24490 (PB–90-137837/XAB) **Health assessment for South Municipal Water Supply Well, Hillsborough County, Peterborough, New Hampshire, Region 1. CERCLIS No. NHD980671069. Preliminary report.** New Hampshire Dept. of Health and Human Services, Concord, NH (USA). Environmental Health Risk Assessment Unit. 11 Apr 1989. 11p. Available from NTIS, PC A03/MF A01.

The South Municipal Water Supply Well Site is on the National Priorities List (NPL). In 1982, use of the 70 foot deep gravel-packed well was curtailed when more than 100 ppb total volatile organic compounds (VOCs) were detected in the well. Volatile organics compounds (VOCs) have been the only hazardous chemicals identified in South Well. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via the consumption of contaminated groundwater and the ingestion of fish potentially contaminated with PCBs found in sediments.

24491 (PB–90-137845/XAB) **Health assessment for Sylvester National Priorities List (NPL) Site, Nashua, Hillsborough County, New Hampshire, Region 1. CERCLIS No. NHD099363541. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 17 Apr 1989. 15p. Available from NTIS, PC A03/MF A01.

The Sylvester National Priorities List (NPL) site is located in Nashua, Hillsborough County, New Hampshire. During the late 1960s, the site began to be used as an illegal waste disposal operation. The site is of potential public health concern because human exposure to volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and heavy metals (metals) may occur and may have occurred in the past via ingestion of, inhalation of and dermal exposure to contaminants in groundwater, surface water, and air.

24492 (PB–90-137852/XAB) **Health assessment for Tibbetts Road, Barrington, New Hampshire, Region 1. CERCLIS No. NHD989090469. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 7 Jan 1986. 6p. Available from NTIS, PC A02/MF A01.

The Environmental Protection Agency Region I Office submitted data indicating trichloroethylene (TCE) was found at 10.5 ppb in the water supply well of Mr. William Vance, Acorn Point Road. In Barrington, New Hampshire estimates of exposure and absorption of TCE at the concentration during bathing and showering have been derived and compared to levels at which adverse effects would not be anticipated. Analyses of the data indicate no concerns to human health from bathing and showering in water with TCE at these levels.

24493 (PB–90-137860/XAB) **Health assessment for Tinkham Garage, Londonderry, New Hampshire, Region 1. CERCLIS No. NHD062004569. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 8 Sep 1986. 11p. Available from NTIS, PC A03/MF A01.

The Tinkham's Garage site is located in Londonderry, New Hampshire, near the intersection of Interstate Route 93 and State Route 102. The primary contamination on this 375-acre site is volatile organic chemicals (VOC's) in the groundwater. There have been very few surface soil samples analyzed. Before completion of the cleanup program, the groundwater should be documented to contain an acceptable concentration of all VOC's and extractable organics present.

24494 (PB–90-137878/XAB) **Health assessment for Central Landfill, Johnston, Rhode Island, Region 1. CERCLIS No. RID980520183. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 15 Mar 1989. 6p. Available from NTIS, PC A02/MF A01.

The Central Landfill Site (CLS) is on the National Priorities List. CLS is owned by the Rhode Island Solid Waste Management

Corporation and supported by state funds. Preliminary on-site sediment sampling results have identified cadmium, barium, lead, perchloroethylene, and chlorobenzene. Arsenic, lead, and mercury were identified in subsurface soil. In addition, 2,4-D, and 2,4,5-T were identified in on-site groundwater. The site is considered to be of imminent public health concern because of the risk to human health caused by the likelihood of human exposure to hazardous substances. Direct contact and ingestion of contaminated groundwater and soil are the human exposure pathways of concern.

24495 (PB–90-137886/XAB) **Health assessment for Davis GSR Landfill, Glocester, Rhode Island, Region 1. CERCLIS No. RID980731459. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 6p. Available from NTIS, PC A02/MF A01.

The Davis GSR Landfill (GSR) is listed by the U.S. Environmental Protection Agency on the National Priorities List. Preliminary on-site sampling results have demonstrated volatile organic compounds in ground water and surface water. The contaminants present in groundwater at this site are trichloroethylene, ethylbenzene, toluene, chloromethane, tetrahydrofuran, 1,1,1-trichloroethane, and 1,2 dichloroethane. GSR represents a potential public health concern to area residents. However, information available on this site is not currently adequate to determine if a public health concern exists to these residents. At a minimum, future investigations of this site should include a characterization of the site and site contaminants, and a characterization of the hydrogeology of the area.

24496 (PB–90-137894/XAB) **Health assessment for Davis Liquid Chemical Waste, Smithfield, Providence Co., Rhode Island, Region 1. CERCLIS No. RID980523070. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 4 Apr 1986. 11p. Available from NTIS, PC A03/MF A01.

The Davis Liquid Chemical Waste Disposal Site is 15 acres in size and lies in the town of Smithfield, Providence County, Rhode Island. Samples of liquids taken in 1977 contained chloroform, carbon tetrachloride, benzene, trichloroethylene, acetone, methylene chloride, and ethyl acetate. The levels of contamination on-site pose a small risk for skin and mucuous membrane irritation due to contact with the surface soil. The levels in the ground water pose a greater risk if exposure occurs.

24497 (PB–90-137902/XAB) **Health assessment for Landfill and Resource Recovery (L and RR) National Priorities List (NPL) Site, North Smithfield, Providence County, Rhode Island, Region 1. CERCLIS No. RID093212439. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 14 Apr 1989. 30p. Available from NTIS, PC A03/MF A01.

The Landfill and Resource Recovery (L&RR) National Priorities List (NPL) site is a closed 28-acre landfill in North Smithfield, Providence County, Rhode Island. The L&RR site is of public health concern because of the risk to human health resulting from probable exposure to hazardous substances at concentrations that may result in adverse human health effects. The contaminants of concern associated with this site are several volatile organic compounds (VOC's) such as trichloroethylene (TCE) and benzene, and metals, including lead and arsenic, present in groundwater, soil, surface water, and air.

24498 (PB–90-137910/XAB) **Health assessment for Peterson/Puritan, Inc., Cumberland, Providence County, Rhode Island, Region 1. CERCLIS No. RID055176283. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

The Peterson/Puritan Inc. Site (PPS) is on the National Priorities List. The PPS on-site comprises 17 acres and contains 3 buildings and a chemical warehouse. Preliminary on-site sampling results have identified polychlorinated biphenyls (PCBs) as Aroclor 1260 or 1254. Lead, cadmium, arsenic, and chromium were identified in on-site sediment. In addition, various volatile organic compounds (VOCs) were detected in on-site surface water. VOCs include: chloroform, benzene, chlorobenzene, and acetone. The site is considered to be of public health concern because of the risk to human health caused by the likelihood of human exposure to hazardous substances.

24499 (PB–90-137928/XAB) **Health assessment for Picillo Farm, Town of Coventry, Rhode Island, Region 1. CERCLIS No. RID980579056. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 1990. 13p. Available from NTIS, PC A03/MF A01.

Picillo Farm is on the National Priorities List. The site was discovered in the fall of 1977 because of an explosion and fire. The soil piles are contaminated primarily with polychlorinated biphenyls (PCB's) and phenols. The groundwater on-site and off-site is contaminated with volatile organic compounds (VOC's). The site remains a potential public health concern because of the concentrations of contaminants remaining in the groundwater and possibly in on-site soils.

24500 (PB–90-137936/XAB) **Health assessment for Stamina Mills Site, North Smithfield, Providence County, Rhode Island, Region 1. CERCLIS No. RID980731442. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 15 Nov 1988. 8p. Available from NTIS, PC A02/MF A01.

The Stamina Mills site is on the National Priorities List (NPL). The environmental contamination of concern consists of methylene chloride, chromium, lead, nickel, trichloroethylene, perchloroethylene, and 1,2-dichloro- ethylene in groundwater; trichloroethylene, 1,2-dichloroethylene, methylene chloride, and nickel in surface water; trichloroethylene, 1,2-dichloroethylene, chloroform, methylene chloride, cyanide, 2-butanone, cadmium, lead, chromium, nickel, and dieldrin in soil; and chloroform, lead, nickel, and chromium in sediment. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via soil, sediment, and surface water.

24501 (PB–90-137944/XAB) **Health assessment for Western Sand and Gravel National Priorities List (NPL) Site, Burrillville, Rhode Island, Region 1. CERCLIS No. RID009764929. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 12 Apr 1989. 16p. Available from NTIS, PC A03/MF A01.

The Western Sand and Gravel National Priorities List (NPL) Site is located near the Slatersville Reservoir in Burrillville, Rhode Island. Septic and chemical wastes were dumped into unlined seepage lagoons at the former gravel mine from 1975 through May 1979. Contaminants, volatile organic compounds (VOCs), from the site appear to have migrated into the groundwater and affected offsite residential water supply wells. The site is of potential public health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects.

24502 (PB–90-137951/XAB) **Health assessment for Old Springfield Landfill, Windsor County, Vermont, Region 1. CERCLIS No. VTD000860239. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 27 Oct 1986. 9p. Available from NTIS, PC A02/MF A01.

The Old Springfield Landfill is in Windsor County, Vermont. Sampling results indicate that on-site surface soil and water, groundwater, and leachate seeps are contaminated with volatile organic and semivolatile organic compounds. Polychlorinated biphenyls (PCBs) and some inorganic compounds may be present at greater than background concentrations. Risk characterization is inaccurate according to procedures prescribed by the Environmental Protection Agency (EPA). Similarly, the SR erroneously states that relatively high soil PCB concentrations were found on-site (e.g., 12,000 mg/kg). The correct units of concentration are ug/kg, and these results do not suggest extensive contamination with PCBs. ATSDR cannot comment on public health implications using the Endangerment Assessment, EA-SR, or SR in their present forms.

24503 (PB–90-137985/XAB) **Health assessment for Sullivan's Ledge, New Bedford, Massachusetts, Region 1. CERCLIS No. MAD980731343. Final report.** Massachusetts Dept. of Public Health, Boston, MA (USA). 10 Apr 1989. 33p. Available from NTIS, PC A03/MF A01.

The Sullivan's Ledge National Priorities List (NPL) Site is a former granite quarry used as an industrial landfill from around 1940 until the 1970's. Groundwater sampling was conducted immediately

adjacent to the quarry pits. The migration of contaminants to off-site locations has been documented. Polychlorinated biphenyls (PCBs) were the most prevalent contaminants detected and were found in surface soils and sediments both on-site and off-site, and as airborne contaminants above the site. Soil and sediment contamination by polycyclic aromatic hydrocarbons (PAHs) also occurs. Volatile organic compounds (VOCs: benzene, vinyl chloride, trichloroethylene, and trans-1,2-dichloroethylene) present in groundwater have contaminated surface water through seepage to a stream along the eastern border of the site. The site is of public health concern because of the risk to human health resulting from probable exposure to hazardous substances at concentrations that may result in adverse health effects.

24504 (PB–90-137993/XAB) **Health assessment for Wells G and H Site, Woburn, Massachusetts, Region 1. CERCLIS No. MAD980732168. Final report.** Massachusetts Dept. of Public Health, Boston, MA (USA). 25 Apr 1989. 56p. Available from NTIS, PC A04/MF A01.

The National Priority List (NPL) site, Wells G and H, were used from 1964 to 1979 to supplement Woburn drinking water supplies. The ground water extracted from Wells G and H was found to be contaminated with volatile organic compounds in 1979. The predominant ground water contaminants are trichloroethylene, tetrachloroethylene, trans-1,2-dichloroethylene and 1,1,1-trichloroethane. Ground water and both surface and subsurface soil contamination on-site is extensive and results from: liquid-waste spills on the ground, sludge disposal, buried and surface disposal of 55-gallon drums, and leaking tanks. A potential exists for human exposure to contaminants by: (1) inhalation of fugitive dusts and vapors from surface soils, industrial use of contaminated well water, and migration of vapors from contaminated shallow ground water to the inside of buildings; (2) dermal contact with contaminated surface soils and contaminated industrial well water; and (3) ingestion of fugitive dusts, surface soils, and, possibly, contaminated fish and contaminated industrial well water. Contaminated sediments also pose a potential exposure source should direct contact occur. The site is of public health concern.

24505 (PB–90-138009/XAB) **Health assessment for Brunswick Naval Air Station, Brunswick, Cumberland County, Maine, Region 1. CERCLIS No. ME8170022018. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 7p. Available from NTIS, PC A02/MF A01.

The Brunswick Naval Air Station (BWK) Site is listed by the U.S. Environmental Protection Agency (EPA) on the National Priorities List. The site is located in Brunswick (Cumberland County), Maine, and encompasses 7 waste areas within a 2-mile radius occupying 15 acres. Five of the seven sites were used to dispose various acids, caustics, and asbestos wastes. Preliminary on-site sampling results have identified various volatile organic compounds (VOCs) and heavy metals in groundwater. The site-related contaminants include: Chloroform, trichloroethylene, bis 2 ethylhexylphalate, lead, chromium, and mercury. On-site surface water contaminants identified include: total organics, chloroform, and chromium. Off-site surface water sampling results identified cadmium and mercury. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances through direct contact and ingestion of contaminated groundwater, surface water, sediment and soil. Access to the waste areas inside the base should be restricted, if not already.

24506 (PB–90-138017/XAB) **Health assessment for W. R. Grace and Company, Acton, Massachusetts, Region 1. CERCLIS No. MAD001002252. Preliminary report.** Massachusetts Dept. of Public Health, Boston, MA (USA). 12 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

The W. R. Grace and Company (Grace) site is listed by the U.S. Environmental Protection Agency (EPA) on the National Priorities List (NPL). The 200-acre site is located off Independence Road in Acton and Concord and near the Maynard and Sudbury town lines. On-site contamination is present as sludge in the lagoons, landfill, and on the ground, in soil beneath the sludge and landfill, in surface water present in the lagoons, in sediment within the lagoons, and in ground water, especially, in the perched aquifer beneath the landfill. Contaminants in the sludge, determined mostly using aqueous or organic extracts of the sludge, includes 1,1-dichloroethylene, vinyl chloride, benzene, ethyl benzene, di-N-butylphthalate, and arsenic. Soils contained arsenic, 1,1-dichloroethylene, and lesser amounts of the same VOC's present in sludge. Surface water contained methylene chloride and sediments contained cadmium. Ground water contained 1,2-dichloroethane, 1,2-dichloropropane, benzene, toluene, ethyl benzene, methylene chloride, vinyl chloride, 1,1-dichloroethylene, trichloroethylene, lead, arsenic, chromium, and nickel. Concentration values given are the maximum levels detected. The site is considered to be of public health concern because of the risk to human health caused by the likelihood of exposure to levels of hazardous substances capable of causing adverse health effects via direct contact with contaminated sludge by workers and trespassers at the site, with contaminated surface water by recreational users of the nearby Fort Pond Brook and Assabet River, and from contaminated drinking water should breakthrough of the activated carbon purification system occur. To reduce the likelihood of adverse health impacts from exposure to on-site contaminants, fencing of the site is recommended.

24507 (PB–90-138033/XAB) **Health assessment for F. O'Connor, Augusta, Kennebec County, Maine, Region 1. CERCLIS No. MED018980027. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 7p. Available from NTIS, PC A02/MF A01.

The F. O'Connor Site (FOC) is on the National Priorities List. FOC recycled capacitors, transformers, and scrap metal for about 20 years. Preliminary on-site soil sampling results have identified PCB's, various PAH's, and various metals such as lead, nickel, chromium, arsenic, and mercury. On-site groundwater sampling results detected 1,4-dichlorobenzene and PCB's. The site is considered to be of potential public health concern because of the risk to human health caused by the likelihood of human exposure to hazardous substances.

24508 (PB–90-138041/XAB) **Health assessment for Pinnette's Salvage Yard Site, Washburn, Aroostook County, Maine, Region 1. CERCLIS No. MED980732291. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 20 Apr 1989. 6p. Available from NTIS, PC A02/MF A01.

The Pinette's Salvage Yard Site (PSY) is on the National Priorities List. In 1979, three transformers were dismantled leaking polychlorinated biphenyls (PCB's) and chlorobenzene on-site. Preliminary on-site sampling results have demonstrated 1,3 dichlorobenzene and 1,4 dichlorobenzene in groundwater, and PCB's, 1,2,4-trichlorobenzene, 1,2 dichlorobenzene, toluene, ethylbenzene, chlorobenzene, xylene, and tetrachloroethylene in soil. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances. Unauthorized persons having access to the site and/or those having direct contact with on-site soil and sediment are at risk of exposure.

24509 (PB–90-138314/XAB) **Superfund Record of Decision (EPA Region 9): Coalinga Asbestos Mine, Fresno County, California (First remedial action), July 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 19 Jul 1989. 120p. (EPA/ROD/R–09-89/036). Available from NTIS, PC A06/MF A01.

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The Coalinga Asbestos Mine site is in Fresno County, California, and is being remediated concurrently with the Atlas Asbestos Mine site. The Record of Decision (ROD) does not address the mines, but rather a separate area in the city of Coalinga, where asbestos, from the Atlas-Coalinga mines, was deposited to await handling and shipment. The site consists of four distinct areas: (1) the warehouse which was once a mining waste distribution center and which currently houses 1,600 cubic yards of mining waste; (2) a storage yard which contains asbestos-contaminated stacked pipes; (3) a shipping yard which was used as an asbestos distribution center by the Coalinga Asbestos Company; and (4) the U.S. Coalinga Company which currently stores piles of asbestos-contaminated mining waste. Subsequent sampling programs, conducted between 1983 and 1987, revealed that surface water and air also contained elevated levels of asbestos. As a result of these findings, EPA

issued an Administrative Order to a major landowner, Southern Pacific Transportation Company (SPTC), requiring SPTC to conduct an additional remedial investigation and a feasibility study and to perform interim measures to stabilize the site. The primary contaminants of concern affecting the soil and debris are metals including nickel, and other inorganics including asbestos and mining wastes. The selected remedial action for this site are included.

24510 (PB–90-138322/XAB) **Superfund Record of Decision (EPA Region 3): Ambler Asbestos Piles, Montgomery County, Pennsylvania (Second remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 56p. (EPA/ROD/R–03-89/080). Available from NTIS, PC A04/MF A01.

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The Ambler Asbestos Piles site is in the southwestern portion of the Borough of Ambler, Montgomery County, Pennsylvania. This second operable unit for the site addresses the CertainTeed asbestos pile portion of the Ambler Asbestos site. The CertainTeed pile was created by the disposal of asbestos-cement scrap originating from asbestos pipe manufacturing operations at the CertainTeed plant. In addition, asbestos-contaminated sludge from a process water treatment settling pond was also disposed of at the site. Several inorganic contaminants have also been detected in the soil and debris of the pile as well as in surface water and sediment from Stuart Farm Creek. Because the actual sources of the inorganic contaminants in the creek have not been identified, a verification study will be performed to define the source of these contaminants. The primary contaminant of concern affecting the soil, sediment, debris, and surface water is asbestos. The selected remedial action for the site are included.

24511 (PB–90-138330/XAB) **Superfund Record of Decision (EPA Region 9): Atlas Asbestos Mine, Fresno County, California (First remedial action), July 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 19 Jul 1989. 120p. (EPA/ROD/R–09-89/035). Available from NTIS, PC A06/MF A01.

Portions of this document are not fully legible.

The Atlas Asbestos Mine site is in Fresno County, California, and is being remediated concurrently with the Coalinga Asbestos Mine site. The Record of Decision (ROD) does not address the mines, but rather a separate area in the city of Coalinga, where asbestos, from the Atlas-Coalinga mines, was deposited to await handling and shipment. The site consists of four distinct areas: the warehouse which was once a mining waste distribution center and which currently houses 1,600 cubic yards of mining waste; a storage yard which contains asbestos-contaminated stacked pipes; a shipping yard which was used as an asbestos distribution center by the Atlas Asbestos Company; and the U.S. Asbestos Company which currently stores piles of asbestos-contaminated mining waste. Subsequent sampling programs, conducted between 1983 and 1987, revealed that surface water and air also contained elevated levels of asbestos. As a result of these finding, EPA issued an Administrative Order to a major landowner, Southern Pacific Transportation Company (SPTC), requiring SPTC to conduct an additional remedial investigation and a feasibility study and to perform interim measures to stabilize the site. The primary contaminants of concern affecting the soil and debris are metals including nickel, and other inorganics including asbestos and mining wastes. The selected remedial action for this site are included.

24512 (PB–90-138348/XAB) **Superfund Record of Decision (EPA Region 6): United Creosoting Company, Conroe, Montgomery County, Texas (Second remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 76p. (EPA/ROD/R–06-89/053). Available from NTIS, PC A05/MF A01.

See also PB–87-190039. Portions of this document are not fully legible.

The 100-acre United Creosoting site is in Conroe, Montgomery County, Texas. The site currently is occupied by a distributing company, a construction company, and a residential subdivision. From 1946 to 1972, the United Creosoting Company operated a wood preserving facility at the site which used PCPs and creosote in the wood preservation process. PCP and creosote wastes were stored in two waste ponds on the property of the distributing company. In 1983, due to the contaminated stormwater runoff from the former waste pond areas, the property owner was directed under terms of an EPA Administrative Order to regrade contaminated soil, divert surface water drainage away from the residential portion of the site, and cap contaminated soil. The Record of Decision (ROD) specifies a final remedy for the contaminated soil and complements a 1986 ROD which determined that no action is necessary to remediate shallow ground water. The primary contaminants of concern affecting the soil are organics including PAHs, PCPs, and dioxins. The selected remedial action for this site are included.

24513 (PB–90-138363/XAB) **Superfund Record of Decision (EPA Region 2): Fulton Terminals Site, Oswego County, New York (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 84p. (EPA/ROD/R–02-89/081). Available from NTIS, PC A05/MF A01.

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The 1.6-acre Fulton Terminals site is in Fulton, Oswego County, New York. The site is bordered to the west by the Oswego River, and a section of the site lies within the river's 100-year floodplain. Commercial and industrial operations are the primary land uses in the vicinity of the site. Spills and leaks of chemical wastes stored in eight tanks at the site resulted in soil and ground water contamination. In 1981, following a citation for not meeting Federal and State standards for the operation of a hazardous waste storage facility, Fulton Terminals initiated a cleanup which included emptying and removing four storage tanks. This remedy addresses the low levels of soil contamination remaining at the site and a plume of contaminated ground water which threatens the Oswego River. The primary contaminants of concern affecting the soil and ground water are VOCs including benzene, TCE, and xylenes; other organics including PAHs; and metals including arsenic. The selected remedial action for this site are included.

24514 (PB–90-138389/XAB) **Superfund Record of Decision (EPA Region 3): Douglassville Disposal, Berks County, Pennsylvania. (Third Remedial Action), June 1989 (Amendment). Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 30 Jun 1989. 105p. (EPA/ROD/R–03-89/071). Available from NTIS, PC A06/MF A01.

See also PB–89-135305. Portions of this document are not fully legible.

The Douglassville Disposal site is a 50-acre abandoned waste oil processing facility in Union Township, Berks County, Pennsylvania. The area surrounding the site includes agricultural land, residences, and light industrial development. The site lies almost entirely within the 100-year floodplain of the Schuylkill River, which borders the site to the north and east. The Schuylkill River is used for municipal and industrial water supply, recreational purposes, and waste assimilation. Further downstream of the site, seven public water supply users draw water from the Schuylkill River. From 1941 to 1979 the site operated as a lubrication oil and waste solvent recycling facility. Wastes generated from the recycling processes were stored onsite in several lagoons. The site consists of a former waste oil processing area and various waste disposal areas. The second and final response action addresses soil and ground water contamination remaining after the former processing facility/tank farm and associated wastes have been removed offsite. This ROD also amends, in part, the 1985 ROD, which outlined the remedial action for the source areas designated as 2, 4, and 5 but deferred a decision regarding ground water contamination. The primary contaminants of concern affecting the soil, sediment, and ground water are VOCs including benzene, toluene, and vinyl chloride; other organics including PAHs, PCBs, and phenol; and metals including lead. The selected remedial action for this site are included.

24515 (PB–90-138397/XAB) **Superfund Record of Decision (EPA Region 1): Wells G and H, Woburn, Massachusetts (First remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 14 Sep 1989. 85p. (EPA/ROD/R–01-89/036). Available from NTIS, PC A05/MF A01.

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The Wells G&H site encompasses 330 acres within the zone of contribution of two municipal drinking water wells known as Well G and Well H, commonly referred to as Wells G&H, in Woburn, Massachusetts. The Aberjona River flows through the site, and a substantial onsite wetlands area is associated with the river's floodplain. Wells G&H were developed in the 1960s and provided over one quarter of the Woburn community water supply. In 1979 the State closed the wells and provided the community with an alternate water supply after detecting several chlorinated volatile organic compounds (VOCs) in the wells. EPA investigations beginning in 1981 resulted in the site being divided into three discrete operable units. Between 1983 and 1989 EPA issued several Administrative Orders to site property owners requiring cleanup activities including limiting site access and removing drums and debris. This Record of Decision (ROD) addresses remediating contaminated soil and groundwater found at the first operable unit, the five properties identified as principal sources of contamination, and further evaluating the remaining operable units. The primary contaminants of concern affecting the soil, sludge, debris, and groundwater are VOCs including PCE and TCE; other organics including carcinogenic PAHs (cPAHs), PCBs, and pesticides; and metals, including lead. The selected remedial action for this site are included.

24516 (PB–90-138405/XAB) **Superfund Record of Decision (EPA Region 5): Ott/Story/Cordova Chemical Site, North Muskegon, Michigan (First remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 103p. (EPA/ROD/R–05-89/111). Available from NTIS, PC A06/MF A01.

Portions of this document are not fully legible.

The Ott/Story/Cordova site is in Dalton Township, Muskegon County, Michigan. Beginning in 1957, various specialty organic chemical manufacturers operated at the site, producing intermediate items used in making pharmaceuticals, dyestuffs, and agricultural chemicals. Soil and water contamination was noted as early as the 1960s, probably resulting from discharge of production vessel clean out wastes and wastewaters to onsite unlined lagoons, and drums of waste that were accumulated onsite. Due to the complexity of the site the cleanup will be organized into two distinct operable units. The first operable unit addresses the interception of contaminated groundwater entering the Little Bear Creek system. The second operable unit will address contaminated soil, possible groundwater remediation, source control, and air and water monitoring. The primary chemicals of concern affecting the groundwater and surface water are VOCs including benzene, PCE, TCE, toluene, vinyl chloride, and xylene; other organics including PCBs and pesticides; and metals including arsenic. The selected remedial action for this site are included.

24517 (PB–90-138447/XAB) **Transport of dissolved substances with second-order reaction.** Yates, S.R.; Enfield, C.G. Environmental Protection Agency, Ada, OK (USA). Robert S. Kerr Environmental Research Lab. c 1989. 8p. (EPA–600/J-89/185). Available from NTIS, PC A02/MF A01.

Pub. in Water Resources Research, Vol. 25, No. 7, 1757-1762(Jul 1989).

There has been great concern about the contamination of soils and aquifers with agricultural, municipal, and industrial pollutants due to the ever-increasing number of contaminated groundwater wells. A mass transport equation which allows coupled second-order reaction between two chemical components in groundwater systems is described. Several analytical solutions to the system of nonlinear equations for advective flow systems have been found, and the features of the solution are illustrated by example. The combined effects of hydrodynamic dispersion and second-order reaction are investigated using a numerical technique, since analytical solutions which allow dispersion were not found. The analytical solutions can be used in the verification of numerical solution techniques especially in advection-dominated transport regimes and can be used to give insight into how the second-order reaction mechanism affects the transport and fate process. The solutions can also be used to determine the second-order reaction coefficient from batch reactor or advective flow experiments.

24518 (PB–90-138454/XAB) **Dissolved oxygen and methane in water by a GC headspace equilibration technique.** Kampbell, D.H.; Wilson, J.T. Environmental Protection Agency, Ada, OK (USA). Robert S. Kerr Environmental Research Lab. c 1989. 11p. (EPA–600/J-89/186). Available from NTIS, PC A03/MF A01.

Pub. in International Jnl. of Environmental Analytical Chemistry, Vol. 36, 249-257(Aug 1989).

An analytical procedure is described for the determination of dissolved oxygen and methane in groundwater samples. The method consists of generating a helium gas headspace in a water filled bottle, and analysis of the headspace by gas chromatography. Other permanent gases such as nitrogen, and volatile aliphatic hydrocarbons such as ethane, propane, and butane could also be analyzed. BTX analyses could also be done on the sample. Detection limit for oxygen was 0.1 mg/1 and 0.002 mg/1 for methane. Good agreement was shown between Winkler titration and the GC-Headspace Equilibration Technique for oxygen analyses by a linear regression coefficient, R(sup 2)=0.998. Oxygen was greatly depleted in some field samples when they were stored for 30 days at 4 C without hydrochloric acid preservation.

24519 (PB–90-138637/XAB) **Removal of toxic heavy metals from contaminated ground water by a fungal adsorption process. Final Technical report, 15 September 1986-14 September 1989.** Huang, C.P.; Morehart, A.L.; Huang, C.J.; Westman, D.C.; Quirk, K. Delaware Univ., Newark, DE (USA). Dept. of Civil Engineering. 1989. 136p. Available from NTIS, PC A07/MF A01.

The metal adsorption behavior of 12 species of fungi was investigated using batch reactors. Specific surface area and surface characteristics of the fungal biomass were determined. Two typical fungal species, Aspergillus oryzae and Saccharomyces cerevisiae were chosen for further investigation. Factors such as growth conditions, pretreatment of biomass and pH of the metal solution were thoroughly studied. The results indicate that the optimum growth condition for metal take-up by A. oryzae biomass was at the C/N ratio of 10 - 15. The amounts of Cu(II), Cd(II), Zn(II) and Ni(II) removal increased with pH. The removal of Pb(II) by fungal biomass is pH-independent. Metal-laden fungal biomass can be regenerated by acid-washing. Moreover, the acid-washing is the most effective pretreatment of biomass for heavy metal removal.

24520 (PB–90-140468/XAB) **Health assessment for Anniston Army Depot, Bynum, Calhoun County, Alabama, Region 4. CERCLIS No. AL3210020027. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 29 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

The Anniston Army Depot (ANAD) facility, which occupies 15,200 acres in northeast Alabama, was originally an ammunition storage depot. Contaminants of concern include trichloroethylene (TCE), cis- and trans-dichloroethylene, methylene chloride, metals, and phenol in groundwater. Based on the available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances.

24521 (PB–90-140476/XAB) **Health assessment for Ciba-Geigy Corporation (McIntosh Plant), McIntosh, Washington County, Alabama, Region 4. CERCLIS No. ALD001221902. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 19 Jan 1989. 7p. Available from NTIS, PC A02/MF A01.

The Ciba-Geigy Corporation site is on the National Priorities List. It also is a Resource Conservation and Recovery Act (RCRA) site. The 1,500-acre site is the location of an active facility (disposal operations carried out under the RCRA permitting process) which produces organic chemicals, pesticides, agricultural and synthetic resins. Past disposal practices utilized several on-site landfills and an open burning area. The environmental contamination on-site consists of DDT, lindane, hexachlorobenzene, and benzo(a)pyrene in soil; chlorobenzene, methylene chloride, phenols, and toluene in surface water; and chromium and mercury in sediment. Based on the available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via groundwater, soil, sediment, surface water, and air.

24522 (PB–90-140484/XAB) **Health assessment for Interstate Lead Company, Leads, Alabama, Region 4. CERCLIS No. ALD041906173. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 7p. Available from NTIS, PC A02/MF A01.

The Interstate Lead Company (ILCO) is on the National Priorities List. The active site is located in Leads (Jefferson County), Alabama. ILCO is an active lead battery reclamation facility. Slag from reclamation operations was used as fill in 7 known off-site locations. Preliminary on-site sampling results have identified lead (in soil, surface water/sediment, and in groundwater), chromium (in soil and in groundwater), nickel (in soil, in surface water/sediment, and in groundwater), and arsenic (in surface water/sediment and in groundwater). ILCO represents a potential public health concern to area residents through direct contact and ingestion of contaminated soil, and groundwater.

24523 (PB–90-140492/XAB) **Health assessment for Olin Corporation, McIntosh, Washington County, Alabama, Region 4. CERCLIS No. ALD008188708. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 19 Jan 1989. 8p. Available from NTIS, PC A02/MF A01.

The Olin Corporation site is on the National Priorities List. The 1,500-acre site has been used since the 1950s to manufacture chlorine and caustic soda using a mercury core process. The environmental contamination on-site consists of benzene, carbon tetrachloride, chlorobenzene, chloroform, 1,2-dichlorobenzene, 1,4-dichlorobenzene, toluene, chromium, lead, nickel, mercury, and other chlorinated benzenes in groundwater. Based on the available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via groundwater, surface water, soil, and sediment.

24524 (PB–90-140500/XAB) **Health assessment for Mowbray Engineering Company, Greenville, Alabama, Region 4. CERCLIS No. ALD031618069. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 18 Aug 1986. 11p. Available from NTIS, PC A03/MF A01.

The Agency for Toxic Substances and Disease Registry was requested to review the Remedial Investigation/Feasibility Study (RI/FS) report on the Mowbray Engineering Company in Greenville, Alabama. The site was used for reconditioning used electrical transformers and dielectric fluid containing PCBs. It is concluded that the site presents little public health threat. However, there are some areas identified in the RI/FS as having PCB contamination that could lead to future degradation of the environment and, if left untreated, could result in human contact with PCBs. Other areas, considering the probable future industrial use of the site, will not pose a public health threat.

24525 (PB–90-140518/XAB) **Health assessment for Perdido Groundwater Contamination National Priorities List (NPL) Site, Perdido, Alabama, Region 4. CERCLIS No. ALD980728703. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 6 Jan 1989. 15p. Available from NTIS, PC A03/MF A01.

The Perdido Groundwater Contamination National Priorities List Site is located in the town of Perdido, Alabama. Benzene, from a 1965 train derailment and possibly from eight underground storage tanks located near the derailment site, has contaminated the local potable groundwater aquifer and nine private wells. Monitoring data indicate that the groundwater contamination has not migrated greater than one mile from the derailment site. All residences and businesses within one mile down gradient of the derailment site have been connected to the Atmore, Alabama, municipal water supply system. Surface soil contamination occurred as a result of the spill. Workers cleaning up the spill site may have received short-term inhalation and dermal contact exposures to benzene. Soil samples collected in 1982 contained low residual levels of benzene that are not likely to be of public health concern.

24526 (PB–90-140534/XAB) **Health assessment for American Creosote Works, Pensacola, Florida, Region 4. CERCLIS No. FLD008161994. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 6 Jan 1986. 10p. Available from NTIS, PC A02/MF A01.

Wood preserving was carried out at the American Creosote site for about 80 years, until 1981. Polynuclear aromatic hydrocarbons and pentachlorophenol disposal resulted in groundwater and on- and off-site soil contamination. The extent of groundwater contamination is incompletely defined at present. The risk assessment done by the contractor seems to be unnecessarily conservative because of several of the assumptions used, some of which are scientifically invalid. The report does not recommend an appropriate remediation alternative from those provided by the contractor, but it is doubtful that complete removal of contaminated soil and extensive groundwater recovery are necessary for protection of the public health.

24527 (PB–90-140542/XAB) **Health assessment for Bay Drums, Tampa, Florida, Region 4. CERCLIS No. FLD088783865. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 17 Jul 1989. 8p. Available from NTIS, PC A02/MF A01.

The Bay Drum's Site (BDS) is listed on the National Priorities List. The 10-acre site, an inactive recycling operation, is located adjacent to two NPL sites in Tampa (Hillsborough County), Florida. Three unlined holding ponds on-site contained various organic solvents and pesticide residues. Preliminary on-site surface water sampling results have identified various volatile organic compounds. They include 1,2-dichloroethene, 4-methyl phenol, ethyl ether, acetone, and unspecific chromium. Groundwater sampling results identified toluene, vinyl chloride, and 1,1-dichloroethene. Sediment sampling results identified chlordane, vinyl chloride, chromium, lead, and cobalt. Soil sampling results identified polychlorinated biphenyls and ethyl ether. Based on available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances.

24528 (PB–90-140559/XAB) **Health assessment for Brown Wood Preserving Site, Suwannee County, Live Oak, Florida, Region 4. CERCLIS No. FLD980728935. Final report.** Florida State Dept. of Health and Rehabilitative Services, Tallahassee, FL (USA). 24 Apr 1989. 16p. Available from NTIS, PC A03/MF A01.

The Brown Wood Preserving site is a National Priorities List (NPL) site located at the intersection of Saw Mill Road and Gold Kist Road, west of the city of Live Oak, Suwannee County, Florida. Surface soil and surface water at the disposal lagoon area were contaminated with polynuclear aromatic hydrocarbons (PAHs). Groundwater was also tested for PAHs with none found; however, analytical detection limits were greater than appropriate health-based guideline values. The site is located in an area of intermediate karst (sinkhole) development. This area of direct aquifer recharge is surrounded by residences using private potable wells. The exposures of concern for humans include dermal absorption and inhalation of dust from contaminated surface soil. Residents reside 100 feet northwest of the site and may constitute a susceptible population because of their proximity to contaminated soils.

24529 (PB–90-140567/XAB) **Health assessment for Cabot Carbon/Koppers Site, Clachua County, Gainsville, Florida, Region 4. CERCLIS No. FLD980709356. Final report.** Florida State Dept. of Health and Rehabilitative Services, Tallahassee, FL (USA). 24 Apr 1989. 17p. Available from NTIS, PC A03/MF A01.

The former location of Cabot Carbon Corporation is a 49-acre site near the intersection of North 23rd Avenue and North Main Street in Gainesville, Alachua County, Florida. The Koppers site is located on 82 acres of land immediately west of the former Cabot property. The Remedial Investigation report of May 1987 indicated that sediments from the ditches, lagoons, and soils of both sites had high concentrations of arsenic. Surficial aquifers of both sites were contaminated with arsenic, chromium, 2,4-dimethylphenol, and benzene; the Kopper site surficial aquifer also contained 4,6-dinitro-o-creosote. Intermediate aquifers of both sites were contaminated with chromium. The site is of a potential health concern because of the potential risk to human health resulting from possible exposure to hazardous substances at concentrations that result in adverse health effects. Human exposure may occur via contact

with contaminated groundwater. Persons may be exposed to arsenic through contact with contaminated surface soil.

24530 (PB–90-140575/XAB) **Health assessment for City Industries (Aka City Chemical), Orange County, Orlando, Florida, Region 4. CERCLIS No. FLD055945653. Preliminary report.** Florida State Dept. of Health and Rehabilitative Services, Tallahassee, FL (USA). 19 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

The City Chemical Company, Aka City Industries, Inc., operated from 1971 to August 1983 and was involved in the receipt, handing, storage, reclamation, and disposal of a wide variety of waste chemicals. Contaminants of concern in surface water are 1,1,1-trichloroethane, trichloroethene, tetrachloroethene, toluene, xylenes, and Freon. Contaminants in groundwater are: methylene chloride, chloroform, dichlorobromomethane, 1,1-dichloroethane, 1,2-dichloroethane, 1,1,1-trichloroethane, 1,1-dichloroethene, trans-1,2-dichloroethene, trichloroethene, tetrachloroethene, benzene, chlorobenzene, ethyl benzene, n-propylbenzene, m-buylbenzene, toluene, xylenes, bis(2-ethylhexyl)phthalate, carbon disulfide, acetone, caprolactan, chromium, lead, manganese, barium, iron, aluminum, and benzo(a)pyrene. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via groundwater.

24531 (PB–90-140583/XAB) **Health assessment for Coleman Evans Wood Preserving Site, Whitehouse, Florida, Region 4. CERCLIS No. FLD991279894. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 21 Aug 1989. 11p. Available from NTIS, PC A03/MF A01.

The Coleman Evans Wood Preserving Site is an 11-acre National Priorities List site located in Whitehouse, Duval County, Florida, approximately 8 miles west of Jacksonville. The site is an active wood treatment facility which began operating in 1954 and uses fuel oil and pentachlorophenol (PCP) in the treatment process. The contamination is generally within the upper 10 feet of the surface with the highest concentrations coinciding with the water table. However, PCP has been detected to depths of 35 feet in the landfill area. Off-site surface soil, water, and sediments are also contaminated with PCP. The contamination of the surface water and sediment extends several hundred feet along a drainage ditch which runs through a residential area. The surficial soil contamination appears consistent with surface water runoff patterns. Groundwater analyses indicated the PCP contamination is limited to the surficial aquifer. The site is of potential public health concern because of the migration of PCP off-site by surface water runoff and the potential for contaminating the aquifer used for domestic purposes by area residents.

24532 (PB–90-140591/XAB) **Health assessment for Broward County Landfill (Aka Davie Landfill), Davie, Broward County, Florida, Region 4. CERCLIS No. FLD980602288. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 9p. Available from NTIS, PC A02/MF A01.

The Broward Count Landfill (aka Davie Landfill, South Broward Landfill, and Broward County Solid Waste Disposal Facility), which began operations in 1964, is located 10 miles southwest of Fort Lauderdale, Florida. The site consists of a 48-acre solid waste landfill, a 68-acre sanitary landfill and a 4-acre sludge lagoon. The solid waste landfill was used to dispose of the municipal solid waste being incinerated at the on-site incinerator. Ammonia, chlorides, sulfate, nitrates, and iron were found in the surface water (borrow pits) on-site. Sludge from the lagoon was found to contain cyanide. Soils on-site have been contaminated with a variety of compounds related to previous landfill activities. The groundwater on-site and downgradient of the site shows elevated levels of sulfate, chloride, lead, and ammonia. Benzene, vinyl chloride, and some unidentified compounds have been detected in monitoring wells and private wells to the south of the landfill. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via on-site ingestion, inhalation, and dermal contact exposures to contaminants present in soil, groundwater, surface water, sediments, and air and off-site ingestion, inhalation, and direct contact exposures to contaminants present in groundwater.

24533 (PB–90-140617/XAB) **Health assessment for Florida Steel, Martin County, Indiantown, Florida, Region 4. CERCLIS No. FLD050432251. Preliminary report.** Florida State Dept. of Health and Rehabilitative Services, Tallahassee, FL (USA). 19 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

The Florida Steel Corporation Site is a steel mill which used an electric furnace process to melt metal scrap and fabricate it into various products. The site was operated from November 1970 to February 1982 when it closed for economic reasons. Contaminants of concern in emission control are arsenic, cadmium and lead. Shallow groundwater contaminants are lead, cadmium, sodium, gross alpha, radium, iron, zinc, and chloride. Contaminants in the intermediate aquifer are lead, cadmium, sodium, radium, iron, and chloride. The deep groundwater contaminant of concern is iron. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances at concentrations that may result in adverse human effects. Human exposure to lead, cadium, sodium and radium may occur through direct contact or ingestion of contaminated groundwater.

24534 (PB–90-140625/XAB) **Health assessment for Gold Coast Oil, Miami, Florida, Region 4. CERCLIS No. FLD071307680. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 30 Mar 1987. 7p. Available from NTIS, PC A02/MF A01.

The Gold Coast Oil site covers 2 acres of flat, sandy land located in a light-industrial area in Miami, Dade County, Florida. The property, owned by the Seaboard Coast Line Railroad, was leased to Gold Coast Oil Corporation, who operated a solvent reclaiming facility and bulk storage area at the site for 11 years from 1971 through 1982. All wastes generated by the solvent recovery operations were disposed of (i.e., distillation blowdown sprayed directed onto the ground) or stored on-site (i.e., drums of sludge-contaminated soil, paint sludges, and still bottom waste). No wastes were shipped off-site until 1982. The public health threat posed by the site is somewhat tenuous and remote since no evidence of a human exposure pathway for site contaminants has been demonstrated and is, at worst, one of the various contributors to the overall contamination of the Biscayne Aquifer.

24535 (PB–90-140633/XAB) **Health assessment for Harris Corporation, Brevard County, Palm Bay, Florida, Region 4. CERCLIS No. FLD000602334. Preliminary report.** Florida State Dept. of Health and Rehabilitative Services, Tallahassee, FL (USA). 19 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

The Harris Corporation National Priorities List (NPL) Site occupies over 500 acres in Palm Bay, Brevard County, Florida. The site consists of the Harris Corporation and the General Development Utilities, Inc. (GDU). Harris has two major operating divisions: the Semiconductor Sector and the Government Systems Sector. They provide a wide variety of electronic devices and components. GDU provides the water supply, treatment and disposal for at least 37,000 residents in Palm Bay. GDU's well field is located south of the Harris complex, adjacent to and down gradient from the Harris complex. Contaminants of concern in the surficial aquifer are: trichloroethene, 1,1-dichloroethene, t-1,2-dichloroethene, vinyl chloride, methylene chloride, chlorobenzene, tetrachloroethene, chromium, and lead. Intermediate aquifer contaminants are: trichloroethene, 1,1-dichloroethene, t-1,2-dichloroethene, vinyl chloride, and methylene chloride. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances. There is a possibility of off-site migration of contaminated ground water.

24536 (PB–90-140658/XAB) **Health assessment for Hollingsworth Solderless Terminal Company, Broward County, Fort Lauderdale, Florida, Region 4. CERCLIS No. FLD004119681. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 7 Apr 1989. 13p. Available from NTIS, PC A03/MF A01.

The Hollingsworth Solderless Terminal Company National Priorities List Site is located in Fort Lauderdale, Broward County, Florida. The site is located in a light to medium industrial area.

There are volatile organic compounds (VOCs) (trans-12-dichloroethane and trichloroethene) present in the groundwater and VOCs and several heavy metals (copper and tin) present in the soil. The Record of Decision (ROD) signed April 1986, mandated several remedial actions which included excavation, ventilation, and replacement of treated soils and recovery, treatment, and reinjection of contaminated groundwater.

24537 (PB–90-140666/XAB) **Health assessment for Kassouf-Kimerling National Priority List (NPL) Site, Tampa, Hillsborough County, Florida, Region 4. CERCLIS No. FLD980727820. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 11 Aug 1988. 14p. Available from NTIS, PC A03/MF A01.

The Kassouf-Kimerling Site is an National Priorities List site located in Tampa, Hillsborough County, Florida. The primary contaminants found at the site are lead, arsenic and cadmium. The site is of potential public health concern because of the risk to human health that could result from possible exposure to hazardous substances at levels that may result in adverse health effects over time. Potential human exposure to several metals may occur via ingestion and dermal absorption of contaminated groundwater, surface water, sediments, and soils and inhalation of contaminated soils. A health effects study for the site is not recommended at this time.

24538 (PB–90-140690/XAB) **Approximate and analytical solutions for solute transport from an injection well into a single fracture.** Chen, C.S.; Yates, S.R. New Mexico Inst. of Mining and Technology, Socorro, NM (USA). Dept. of Geoscience. c 1989. 12p. Available from NTIS, PC A03/MF A01.

Pub. in Ground Water, Vol. 27, No. 1, 77-86(Jan/Feb 1989).

In dealing with problems related to land-based nuclear waste management, a number of analytical and approximate solutions were developed to quantify radionuclide transport through fractures contained in the porous formation. It has been reported that by treating the radioactive decay constant as the appropriate first-order rate constant, these solutions can also be used to study injection problems of a similar nature subject to first-order chemical or biological reactions. The fracture is idealized by a pair of parallel, smooth plates separated by an aperture of constant thickness. Groundwater was assumed to be immobile in the underlying and overlying porous formations due to their low permeabilities. However, the injected radionuclides were able to move from the fracture into the porous matrix by molecular diffusion (the matrix diffusion) due to possible concentration gradients across the interface between the fracture and the porous matrix. Calculation of the transient solutions is not straightforward, and the paper documents a contained Fortran program, which computes the Stehfest inversion, the Airy functions, and gives the concentration distributions in the fracture as well as in the porous matrix for both transient and steady-state cases.

24539 (PB–90-140708/XAB) **Anaerobic biodegradation of nitrogen-substituted and sulfonated benzene aquifer contaminants.** Kuhn, E.P.; Suflita, J.M. Oklahoma Univ., Norman, OK (USA). Dept. of Botany and Microbiology. c 1989. 14p. Available from NTIS, PC A03/MF A01.

Pub. in Hazardous Waste and Hazardous Materials, Vol. 6, No. 2, 121-133(1989).

A literature survey of ground water contaminants indicated that aquifers are repositories for hazardous wastes, including N- and S-substituted benzene derivatives. The susceptibility of several anilines, benzamides, benzenesulfonic acids and benzenesulfonamides to anaerobic metabolism by aquifer microorganisms was examined. Under sulfate-reducing and methanogenic conditions the carboxylated anilines were biotransformed within 1 to 3 months while unsubstituted or methylated anilines required longer incubation times. Benzamide as well as an aryl methyl and an N-methyl derivative were biodegraded under both redox conditions. The anerobic degradation of the N-methylated benzamide was favored in sulfate-reducing rather than methanogenic incubations. However, the addition of a second N-alkyl group rendered the resulting compounds resistant to anaerobic decay. Only 1 of 7 benzenesulfonates and 2 of 5 benzene-sulfonamides proved amenable to anaerobic metabolism. The authors found 37-75% of the theoretically expected amount of methane from aquifer slurries amended with the aminobenzoic acids, benzamide, and p-toluamide. In the sulfate-reducing aquifer slurries 89-100% of the oxidized benzamide, p-toluamide and N-methylbenzamide could be accounted for by sulfate reduction. These results help indicate which hazardous waste constituents will likely persist in anoxic aquifers and the types of chemical substitution patterns that favor anaerobic biotransformation.

24540 (PB–90-140898/XAB) **Polychlorinated dibenzo-p-dioxins and dibenzofurans in selected estuarine sediments.** Norwood, C.B.; Hackett, M.; Pruell, R.J.; Butterworth, B.C.; Williamson, K.J. Environmental Protection Agency, Narragansett, RI (USA). Environmental Research Lab. c 1989. 10p. (EPA–600/J-89/180). Available from NTIS, PC A02/MF A01.

Pub. in Chemosphere, Vol. 18, No. 1-6, 553-560(1989).

Biosignificant polychlorinated dibenzo-p-dioxins (PCDDs) and diobenzofurans (PCDFs) were found in estuarine sediments. When these isomer distributions are displayed on a log scale, comparisons of various estuarine sediments reveal significant differences. Principal components analyses display clusters which suggest relationships with different source materials. PCB contaminated sediments have elevated levels of PCDFs.

24541 (PB–90-141003/XAB) **Nonpoint sources: Agenda for the future.** Environmental Protection Agency, Washington, DC (USA). Office of the Assistant Administrator for Water. Jan 1989. 35p. (WH–556). Available from NTIS, PC A03/MF A01.

In 1987, Congress shifted from fifteen years of nonpoint source (NPS) pollution planning and problem identification (1972-1987) to a new National NPS action program. The Act placed special emphasis on NPS by moving the provision from Title II (Grants for Construction of Treatment Works) into Title III (Standards and Enforcement), and by strengthening the basic Declaration of Goals and Policy in 101(a) of the Clean Water Act. The law and its legislative history expressed the intent that Federal and State governments should develop new institutional arrangements and come up with a better division of roles and responsibilities to get the job done. Consistent with 319, States are completing their assessments and management programs, which, after EPA review and approval, will serve as the cornerstone of the National NPS program in the years to come. This National NPS Agenda forms the framework for the National NPS program over the next five years, and will be supplemented by annual EPA work programs that provide additional, detailed information.

24542 (PB–90-141417/XAB) **Health assessment for Montco Research, Putnam County, Hollister, Florida, Region 4. CERCLIS No. FLD061897054. Preliminary report.** Florida State Dept. of Health and Rehabilitative Services, Tallahassee, FL (USA). 19 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

Montco Research Products, Inc. is a production and purification operation for intermediate organic compounds and specialty chemicals. On-site media of concern include the following: arsenic and cyanide in the surface water; benzene, organic halogens and xylenes in groundwater; arsenic in soil. Naphthalene vapor and dust can form explosive mixtures with air. This property of naphthalene constitutes a physical hazard. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances in surface water, surface soil and groundwater. All of the identified contaminants were detected on site, therefore workers or trespassers would be the population at risk.

24543 (PB–90-141433/XAB) **Health assessment for Northwest 58th Street Landfill, Dade County, Florida, Region 4. CERCLIS No. FLD980602643. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 15 Apr 1986. 12p. Available from NTIS, PC A03/MF A01.

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The Northwest 58th Landfill is owned and operated by Dade County, Florida. The site began disposal operations in 1952 as an open dump and received municipal and industrial wastes until 1982. The Biscayne Aquifer is the sole source of potable water for the Dade County population. The aquifer runs directly under the

landfill. The landfill's major contaminants are arsenic, chromium, zinc, benzene, 1,1,2,2-tetrachloroethene, trichloroethene, vinyl chloride and chlorobenzene. Based on the information presented the groundwater appears to be the major environmental pathway which would lead to human exposure.

24544 (PB–90-141441/XAB) **Health assessment for Parramore Surplus Company, Mt. Pleasant, Florida, Region 4. CERCLIS No. FLD041140344. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 7 Apr 1989. 10p. Available from NTIS, PC A02/MF A01.

The Parramore Surplus Company National Priorities List (NPL) Site is located in Mt. Pleasant, Gadsden County, Florida. The 25-acre site is located northwest of Tallahassee. There are a few small areas of surface soil contamination on-site; one contains an elevated level of lead. The Record of Decision signed September 1987 mandated a no action alternative for source control and monitoring well installation to determine if contamination is present in the groundwater. The sampling of the groundwater indicated that there was no groundwater contamination present. The site has been proposed for deletion from the NPL.

24545 (PB–90-141482/XAB) **Health assessment for Pickettville Road Landfill Site (PRLS), Jacksonville, Duval County, Florida, Region 4. CERCLIS No. FLD980556351. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 15 Jul 1988. 12p. Available from NTIS, PC A03/MF A01.

The Pickettville Road Landfill Site is located in Duval County, Florida. The site lies adjacent to two other waste disposal facilities and to residential areas where groundwater serves as the primary source of potable water. The major contaminants found in groundwater, surface water, soil, and sediment include arsenic, cadmium, lead, fluoranthene and pyrene. The primary environmental pathways for contaminant migration include groundwater, surface water, soil, air, and bioaccumulation in consumable plants and animals. Potential pathways of human exposure include ingestion of contaminated soil, groundwater, or biota, inhalation of fugitive dusts or vapors, or dermal absorption of soil, sediment, or surface water contaminants. Because of the lack of and inconsistencies in quality assurance/quality control data, results of sampling programs were used for qualitative purposes only. As a result, the public health impact of the various pathways of human exposure to contaminants cannot be determined.

24546 (PB–90-141490/XAB) **Health assessment for Piper Aircraft Corporation, Indian River County, Vero Beach, Florida, Region 4. CERCLIS No. FLD004054284. Preliminary report.** Florida State Dept. of Health and Rehabilitative Services, Tallahassee, FL (USA). 19 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

The Piper Aircraft Corporation/Vero Beach Water and Sewer Department National Priorities List Site covers 8 acres in Vero Beach, Indiana River County, Florida. The facility began assembling and painting light aircraft in 1957. Chemicals utilized in these operations are stored on-site in underground storage tanks. In 1978, routine sampling and analysis of the city water supply revealed the presence of four volatile organic compounds: trichloroethene, 1,1-dichloroethene, cis/trans-1,2-dichloroethene and vinyl chloride. Based on available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substance via contaminated groundwater, aerated groundwater that is being discharged to the surface water, and air contaminants released from the groundwater aeration process.

24547 (PB–90-141508/XAB) **Health assessment for Pratt and Whitney Aircraft, Palm Beach County, Florida, Region 4. CERCLIS No. FLD001447952. Preliminary report.** Florida State Dept. of Health and Rehabilitative Services, Tallahassee, FL (USA). 19 Apr 1989. 13p. Available from NTIS, PC A03/MF A01.

The Pratt and Whitney Government Engine Business Division has been in operation as a division of the United Technologies Corporation (UTC) plant since 1958. In the past, materials disposed of in the landfill/incineration trenches at the plant included construction debris, discarded equipment, unknown solid waste from Air Force Plant Number 74, solvents and solvent sludges, asbestos, fuels, paints, pesticide and herbicide container residues, benzonitrite and solvent-contaminated soils, mercury (from bulbs and thermometers), discarded equipment from metal finishing operations, commercial and laboratory chemicals, garbage, and sewage sludge. Based on available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via chemicals in the groundwater and air (wind-blown) and possibly through ingestion of contaminated wildlife.

24548 (PB–90-141516/XAB) **Health assessment for Reeves Southeastern Galvanizing, Tampa, Florida, Region 4. CERCLIS No. FLD000824888. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 4 Jan 1989. 8p. Available from NTIS, PC A02/MF A01.

The Reeves Southeastern Corporation Site (RSS) is on the National Priorities List. RSS encompasses two areas located in close proximity to each other. They include the Reeves Southeastern Galvanizing Site (RSEG) (approximately 17 acres) and the Reeves Southeastern Wire Site (RSEW) (approximately 11 acres). Historically, spent caustic, rinse, and acid process wastes generated at RSEG and RSEW were neutralized and discharged to storage ponds for percolation and evaporation. Preliminary on-site groundwater sampling results have identified chromium unspecific, and aluminum. No further sampling information was reported. Based on available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances.

24549 (PB–90-141532/XAB) **Health assessment for Schuylkill Metals Corporation Site, Plant City, Florida, Region 4. CERCLIS No. FLD062794003. Final report.** Florida State Dept. of Health and Rehabilitative Services, Tallahassee, FL (USA). 24 Apr 1989. 16p. Available from NTIS, PC A03/MF A01.

The Schuylkill Metals Corporation (SMC), located in Plant City, Florida, operated as a secondary lead recovery facility from 1972 to 1986. The SMC facility is currently on the National Priorities List because of documented environmental contamination and vulnerable groundwater resources in the proximity. According to the December 1987 Remedial Investigation report, surficial groundwater at the site is contaminated with lead, nickel and sulfate. Lead was found at high concentrations in surface water and surface soil on site. The high risk populations are residents who live southsoutheast of the site, because the overflow of surface water from the ditch and ponds and migration of contaminated groundwater from the site may contact the nearby residential area.

24550 (PB–90-141540/XAB) **Health assessment for Sherwood Medical Industries, Volusia County, Deland, Florida, Region 4. CERCLIS No. FLD043861392. Preliminary report.** Florida State Dept. of Health and Rehabilitative Services, Tallahassee, FL (USA). 19 Apr 1989. 7p. Available from NTIS, PC A02/MF A01.

The Sherwood Medical Industries site was placed on the National Priorities List in 1982. The plant produces stainless steel medical supplies and generates the following hazardous wastes: 50,000 gal/day of acidic waste water containing chromium; 400 gal/month of electrolytic sludges containing chromium; 206 gal/month of trichloroethylene waste; and 344 gal/month of aliphatic solvent waste. According to 1987 analytical results groundwater at Sherwood Medical was contaminated with trans-1,2-dichloroethylene, tetrachloroethylene, and trichloroethylene; the sources of contamination have not been identified. Based on available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances at concentrations that may result in adverse health effects.

24551 (PB–90-141557/XAB) **Health assessment for 62nd Street NPL Site, Hillsborough County, Tampa, Florida, Region 4. CERCLIS No. FLD980728877. Final report.** Florida State Dept. of Health and Rehabilitative Services, Tallahassee, FL (USA). 24 Apr 1989. 20p. Available from NTIS, PC A03/MF A01.

The 62nd Street National Priorities List site is located in Tampa, Hillsborough County, Florida. Contaminants of concern found at the

site are metals and volatile organic compounds. The site is of potential public health concern because of the risk to human health from possible exposure to hazardous substances at levels that may result in adverse health effects over time. Human exposure to these contaminants may occur via ingestion and dermal absorption of contaminated groundwater, surface water, sediments, and soils. A health effects study for the site is not recommended at this time.

24552 (PB–90-141565/XAB) **Health assessment for Sydney Mine, Hillsborough County, Brandon, Florida, Region 4. CERCLIS No. FLD000648055. Preliminary report.** Florida State Dept. of Health and Rehabilitative Services, Tallahassee, FL (USA). 19 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

The Sydney Mine National Priorities List Site is a former disposal site located in Brandon, Florida. The area was strip-mined for phosphate rock from the 1930s through the 1950s. In late 1973, Hillsborough County leased a portion of the Sydney Mine site from American Cynamid and constructed a sludge disposal pond. The pond received wastes from grease traps, septage waste, and waste oil. Contaminants of concern at the site consist of the following: cadmium, benzene, 1,1-dichloroethane, 1,1-dichloroethene, t-1,2-dichloroethene, toluene, trichloroethene, and xylene. Based on the available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances at concentrations that may result in adverse health effects.

24553 (PB–90-141573/XAB) **Health assessment for Taylor Road, Hillsborough County, Seffner, Florida, Region 4. CERCLIS No. FLD090494959. Preliminary report.** Florida State Dept. of Health and Rehabilitative Services, Tallahassee, FL (USA). 19 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

The Taylor Road National Priorities List site is located one-eighth mile north of the city of Seffner in eastern Hillsborough County, Florida. Three landfills comprise the Taylor Road site: the Taylor Road Landfill which operated from 1975 to 1980; the Department of Transportation Borrow Pit Landfill and the Hillsborough Heights Landfill, both of which operated from 1980 to 1984. The contaminants found in the Floridian Aquifer are: benzene, 1,1-dichloroethene, lead, tetrachloroethene, trichloroethene, and vinyl chloride. Based on the available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances.

24554 (PB–90-141607/XAB) **Health assessment for Varsol Spill, Miami, Florida, Region 4. CERCLIS No. FLD980602346. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 16 Mar 1989. 12p. Available from NTIS, PC A03/MF A01.

The Varsol Spill Site is located in Miami, Dade County, Florida. The site is located at the Miami International Airport. Although the varsol-like contaminant from the spill can no longer be identified in the groundwater, it is believed that the contamination from the spill has contributed to the regional volatile organic compound (VOC) groundwater contamination present in the Biscayne Aquifer. The Record of Decision for the Varsol site, signed March 1985, mandated a no action alternative. However, a study of the Biscayne Aquifer (which included Varsol), conducted to determine the extent of the regional VOC contamination, recommended air stripping towers to remove the contamination present in the groundwater. The project for the Biscayne Aquifer is currently in the design phase.

24555 (PB–90-141615/XAB) **Health assessment for Whitehouse Waste Oil Pits, Whitehouse, Florida, Region 4. CERCLIS No. FLD980602767. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 16 Mar 1989. 15p. Available from NTIS, PC A03/MF A01.

The Whitehouse Waste Oil Pits National Priorities List site is located in Whitehouse, Duval County, Florida. The site is located in a low density residential area. There are volatile organic compounds and several heavy metals present in the groundwater, surface water, soil, and leachate. The Record of Decision (ROD) signed May 1985 mandated several remedial actions which included the construction of a slurry wall around the entire site, the recovery and treatment of contaminated groundwater within the walled area, the removal of contaminated sediments, and surface capping of the entire area. The project is currently in the design phase. The Environmental Protection Agency is considering altering the ROD to conform with the requirements in the Superfund Amendments and Reauthorization Act of 1986 for permanent remedial actions.

24556 (PB–90-141623/XAB) **Health assessment for Yellow Water Road Site, Duval County, Baldwin, Florida, Region 4. CERCLIS No. FLD980844179. Preliminary report.** Florida State Dept. of Health and Rehabilitative Services, Tallahassee, FL (USA). 19 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

Prior to commercial development, the Yellow Water Road site was part of a dairy farm. The American Environmental Energy Corporation was formed in 1981 on the premise that insulation fluids contaminated with polychlorinated biphenyl could be removed from transformers and the transformers salvaged. In June 1986, the site was added to the National Priorities List. Contaminants of concern at the site were warehouse well (groundwater): Aroclor 1260, iron, and lead; stockpiled soil (surface soil): hexachlorobenzene, Aroclor 1248, and Aroclor 1260. Based on the available information, the site is considered to be of public health concern because of the risk to human health caused by the likelihood of exposure to hazardous substances at concentrations that may result in adverse health effects from groundwater.

24557 (PB–90-141631/XAB) **Health assessment for Zellwood Groundwater Contamination Site, Zellwood, Florida, Region 4. CERCLIS No. FLD049985302. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 21 Aug 1986. 11p. Available from NTIS, PC A03/MF A01.

The Zellwood Groundwater Contamination Site, located in Orange County, Florida, is the site of several operations which have added contaminants to the surface and subsurface soil, sediments in nearby streams, and to the surficial aquifer. Contaminants of concern are: arsenic, benzo(a)pyrene, chlordane, chromium, nitrate-nitrogen, and cyanide. The data show that there has been significant contamination of the surface soil, sediments in nearby ditches, and of the surficial aquifer. The levels of contaminants in this aquifer render it unsuitable for consumption.

24558 (PB–90-141649/XAB) **Health assessment for Diamond Shamrock Corporation Landfill, Cedartown, Georgia, Region 4. CERCLIS No. GAD990741092. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 28 Sep 1988. 6p. Available from NTIS, PC A02/MF A01.

The Diamond Shamrock Corporation (DSC) is proposed for listing on the National Priorities List. There is a history of on-site drum burial from 1972 to 1977. DSC buried drummed wastes including fungicides, various oils and oil sludges, esters, ethers, alcohols, and metallic salts in three unlined trenches, six feet deep. The on-site contaminants of concern include cadmium, chromium, copper and zinc, although sampling results have not been reported. On-site contaminants are present in groundwater and subsurface and surface soils. Based on the available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances.

24559 (PB–90-141664/XAB) **Health assessment for Powersville National Priority List (NPL) Site, Powersville, Peach County, Georgia, Region 4. CERCLIS No. GAD980496954. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 11 Aug 1988. 13p. Available from NTIS, PC A03/MF A01.

The Powersville Site, also known as the Peach County Sanitary Landfill, is located in Peach County, Georgia. On-site contaminants include benzene hexachloride, chlordane, chromium, lead, toxaphene, and vinyl chloride. Groundwater samples obtained from on and off-site monitoring wells revealed several contaminants including benzene hexachloride, chromium, lead, and vinyl chloride. Although contaminants found in off-site residential wells were below levels which would impact on public health, the recently signed Record of Decision includes a provision for providing area residents with an alternative water source by connecting residences to a municipal water system. Access to the unfenced portion of the site should be restricted because direct exposure to site contaminants may pose a potential public health threat.

24560 (PB–90-141672/XAB) **Health assessment for Mathis Brothers Landfill, Kensington, Georgia, Region 4. CERCLIS No. GAD980838619. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 29 Sep 1988. 7p. Available from NTIS, PC A02/MF A01.

The Mathis Brothers Landfill (MBL) is on the National Priorities List. MBL is a 20-acre site and is located on the east side of Marble Top Road, one-half mile south of State Highway 136 near Kensington (Walker), Georgia. MBL was licensed by the State to accept nonhazardous waste. The landfill is uncapped and rusted, leaking drums presently exist on-site. No removal operations have occurred. On-site contaminants of concern include lead, various residues from herbicide manufacturing and latex waste from carpet manufacturing. Based on the available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances.

24561 (PB–90-141680/XAB) **Health assessment for Distler Brickyard National Priorities List (NPL) Site, Hardin County, Kentucky, Region 4. CERCLIS No. KYD980602155. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 13p. Available from NTIS, PC A03/MF A01.

The Distler Brickyard National Priorities List site is located in Hardin County, Kentucky. Waste storage activities took place on three acres of the old brickyard facility. Approximately 3,000 persons reside within a four-mile radius of the site. Approximately 70,000 persons depend upon wells within a three-mile radius of the site for domestic water supply. The soils and groundwater on-site are contaminated with volatile organic compounds and lead. Based on information reviewed, the site is of potential public health concern because of the risk to human health resulting from possible exposure to on-site/off-site hazardous substances at concentrations that may result in adverse human health effects.

24562 (PB–90-141698/XAB) **Health assessment for Howe Valley Landfill, Hardin County, Kentucky, Region 4. CERCLIS No. KYD980501191. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 7p. Available from NTIS, PC A02/MF A01.

The Howe Valley Landfill Site is on the National Priorities List. The site is located in Hardin County, Kentucky. Approximately 2,000 to 5,000 drums of wastes reportedly consisting of sludges from various manufacturing operations, plating sludges, galvanizing wastes, silicone polymers, insulation and insulation by-products were disposed of on-site from 1979 to 1986. Preliminary on-site soil/sediment sampling results have identified chromium, lead, aluminum, and cyanide. Preliminary off-site groundwater sampling results identified lead and traces of arsenic, chromium, cadmium, and mercury. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances.

24563 (PB–90-141706/XAB) **Health assessment for Lee's Lane Landfill Site, Louisville, Kentucky, Region 4. CERCLIS No. KYD980557052. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 15 Nov 1985. 13p. Available from NTIS, PC A03/MF A01.

The 112-acre Lee's Lane Landfill site lies in the flood plain along the Ohio River in Jefferson County about 4.4 miles southwest of Louisville, Kentucky and consists of three tracts, Northern, Central and Southern. Between the 1940s and April 1975 when the landfill was closed by the State, the junkyard and landfill received about 2,400,000 cubic yards of domestic, commercial, and industrial wastes. The contaminants of concern are benzene, chromium, lead, and arsenic. Positive efforts should be implemented to minimize any potential health effects and mental stress to the Riverside Gardens residents as well as to potential future users of the landfill.

24564 (PB–90-141714/XAB) **Health assessment for Maxey Flats Disposal Site, Morehouse, Fleming County, Kentucky, Region 4. CERCLIS No. KYD0980729107. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 20 Apr 1989. 24p. Available from NTIS, PC A03/MF A01.

The National Priorities List Maxey Flats Disposal Site is located approximately 10 miles northwest of Morehouse, Kentucky, in Fleming County. The site was initially approved for the disposal of low level radioactive waste in 1963, and by 1977, an estimated maximum of 6 million cubic feet of wastes had been buried. In 1977, radionuclides were found in soil being excavated for additional trenches resulting in the site being closed in December of 1977. In addition to radioactive material, chemical wastes were disposed of in violation of the site license. Furthermore, water has infiltrated these trenches which now require pumping to prevent overflow. Monitoring wells on-site have detected numerous radionuclides, organic and inorganic contaminants in trench leachates produced by the flooding. The primary health concern for the site is the potential exposure to radiation received on-site by occupational workers and off-site by the general public.

24565 (PB–90-141730/XAB) **Health assessment for A. L. Taylor (Valley of the Drums), Brooks, Kentucky, Region 4. CERCLIS No. KYD980500961. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 16 Mar 1989. 8p. Available from NTIS, PC A02/MF A01.

The A.L. Taylor, also known as Valley of the Drums (Valley), National Priorities List Site is located in Brooks, Bullitt County, Kentucky. When the site was first investigated, contamination consisted of approximately 17,000 drums above ground and an unknown amount of buried drums and bulk wastes. These wastes originated from paint and coatings manufacturers and resulted in organic and metallic contamination of the site. Historically, contamination at Valley has consisted of metals and organic compounds including: chromium, lead, zinc, benzene, ethylbenzene, trichloroethene, naphthalene, toluene, polychlorinated biphenyls, and cyanide. Based on information reviewed to date, the site is of potential public health concern because of the risk to human health that could result from possible exposure to hazardous substances at levels that may result in adverse health effects.

24566 (PB–90-141748/XAB) **Health assessment for Stauffer Chemical Company National Priorities List (NPL) Sites, Mobile, Alabama, Region 4. CERCLIS Nos. ALD095688875, ALD088161176. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 6 Jan 1989. 21p. Available from NTIS, PC A03/MF A01.

The two Stauffer Chemical Company National Priorities List Sites, Cold Creek and LeMoyne, are active industrial plants on the Mobile River, approximately 20 miles north of Mobile, Alabama. Past waste water disposal practices at the two plants have resulted in the contamination of the soil with thiocarbamates and thiocyanate; the groundwater with carbon tetrachloride, carbon disulfide, and thiocarbamates; and swamp sediment and fish with mercury. The groundwater contamination is presently being collected and treated. Oral exposure to mercury-contaminated swamp sediment and fish are exposure pathways of concern to human health and may pose a significant public health threat. Although no health study follow-up is indicated at this time, further investigation and possible remediation is warranted.

24567 (PB–90-141755/XAB) **Health assessment for Robins Air Force Base, Warner Robins, Houston County, Georgia, Region 4. CERCLIS No. GA1570024330. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 13 Feb 1989. 10p. Available from NTIS, PC A02/MF A01.

Robins Air Force Base is on the National Priorities List. The landfill received general refuse, garbage, and industrial wastes. Groundwater, soil, and leachate samples were taken at Zone One. Surface water and sediment samples were taken only in the drainage ditch. Analyses for the hazardous substance list chemicals were conducted in each environmental media. Based on the available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances.

24568 (PB–90-141763/XAB) **Health assessment for Olin Corporation- Areas 1, 2, and 4, Augusta, Richmond County, Georgia, Region 4. CERCLIS No. GAD040690737. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 5 Dec 1988. 6p. Available from NTIS, PC A02/MF A01.

The Olin Corporation site is on the National Priorities List. The Olin Corporation facility at the site manufactures chlorine and caustic soda, generating a mercury-contaminated brine sludge in the process. Since the early 1970s, Olin has disposed of its waste in two unlined dumps and in a lined surface impoundment. The environmental contamination on-site consists of mercury in groundwater, and mercury in the solid waste materials. In addition, chloride in groundwater has been measured at 155,000 ppm. The environmental contamination off-site consists of mercury and chloride in groundwater. Based on the available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contaminated groundwater, surface water, sediment, and soil.

24569 (PB–90-141771/XAB) **Health assessment for Monsanto Corporation, Augusta, Georgia, Region 4. CERCLIS No. GAD001700699. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 19 Jan 1989. 7p. Available from NTIS, PC A02/MF A01.

The Monsanto Corporation 75-acre site is located in Augusta (Richmond County), Georgia. Preliminary on-site groundwater sampling results (the most recent occurring in 1986) identified arsenic, the only contaminant reported. Based on available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances.

24570 (PB–90-141789/XAB) **Health assessment for Smith's Farm, Shepherdsville, Bullitt County, Kentucky, Region 4. CERCLIS No. KYD097267413. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 15 Nov 1988. 8p. Available from NTIS, PC A02/MF A01.

The Smith's Farm site is on the National Priorities List. The environmental contamination on-site consists of ethylbenzene, bis-(2-ethylhexyl)phthalate, toluene, xylene, polychlorinated biphenyls, arsenic, chromium, lead, and nickel in soil; ethylbenzene, arsenic, mercury, nickel, cadmium, and zinc in surface water; ethylbenzene, toluene, bis-(2-ethylhexyl)phthalate, polychlorinated biphenyls, arsenic, chromium, lead, and nickel in sediment; and 1,1,1-trichlorethane, vinyl chloride, isophorone, benzene, trans-1,2-dichloroethylene, trichloroethylene, xylenes, arsenic, nickel, and lead in leachate. Based on the available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances.

24571 (PB–90-141797/XAB) **Health assessment for Flowood Site, Jackson, Rankin County, Mississippi, Region 4. CERCLIS No. MSD980710941. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 11 Aug 1988. 14p. Available from NTIS, PC A03/MF A01.

The Flowood Site is located in Rankin County, Mississippi. The site lies in a rural area with scattered residents, cattle grazing areas, and industrial operations. The primary contaminants of concern in soils, sediments, and groundwater include lead, and several polynuclear aromatic hydrocarbons. Several water supply wells, including those which provide water for the Flowood municipal water system, are located within three thousand feet of the site. Primary environmental pathways of contaminant migration include groundwater, soil, sediment, air, and foodchain bioaccumulation. Available information was inadequate to determine the significance of human exposure pathways of ingestion of contaminated groundwater and contaminated plants and animals. Contaminant levels are sufficiently high that ingestion of on-site groundwater, soils, and sediments, and off-site surface water could adversely impact human health.

24572 (PB–90-141805/XAB) **Health assessment for Newsom Brothers National Priorities List (NPL) Site, Columbia, Marion County, Mississippi, Region 4. CERCLIS No. MSD980840045. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 12p. Available from NTIS, PC A03/MF A01.

The Newsom Brothers National Priorities List site is located in Marion County, Columbia, Mississippi. A variety of industrial activities have been conducted on-site. In the past, contamination has been detected at levels which, if exposure to those contaminants occurred, could pose a potential concern to public health. Soils, surface water, sediments, and groundwater have been contaminated by volatile organic compounds, heavy metals, polynuclear aromatic hydrocarbons, and various other organic compounds. Low levels of chlorinated dioxins have also been detected on-site. The site is of potential public health concern because of the risk to human health that could result from possible human exposure to hazardous substances at levels that may result in adverse health effects.

24573 (PB–90-141821/XAB) **Health assessment for Bypass 601 Groundwater Contamination, Concord, North Carolina, Region 4. CERCLIS No. NCD044440303. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 4 Nov 1988. 7p. Available from NTIS, PC A02/MF A01.

The Bypass 601 (Martin's Scrap Recycling) site is listed on the National Priorities List. The two-acre site primarily is a battery salvage and metal recycling operation. Past practices included disposing of waste acid on-site or selling it for reclamation, and using spent battery casings for fill material on-site. Maximum environmental contamination on-site consists of arsenic, cadmium, and lead in soil; arsenic, cadmium, and lead in surface water; and arsenic, cadmium, lead, and chromium in groundwater. From the information available, the site is considered to be of potential public health concern due to the risk caused by the possibility of exposure to hazardous substances via surface water, sediments, and groundwater.

24574 (PB–90-141839/XAB) **Health assessment for Cape Fear Wood Preserving, Fayetteville, North Carolina, Region 4. CERCLIS No. NCD003188828. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 12 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

The Cape Fear Wood Preserving site is listed on the National Priorities List. The site is located in Cumberland County, North Carolina, on the western side of Fayetteville near Highway 401. The site consists of 41 acres of which less than 10 acres were developed by the facility. Wood preserving operations began at the facility in 1953 and continued until 1983. Wood was treated using both creosote and the chromium-copper-arsenic process. Contaminants detected in water samples from on-site monitoring wells included benzene, chromium, and polyaromatic hydrocarbons. During earlier investigations, 7 nearby domestic wells in the area were sampled for contamination. The site is considered to be of potential health concern because of the risk to human health caused by the possibility of exposure to hazardous substances.

24575 (PB–90-141847/XAB) **Health assessment for Carolina Transformer Company, East Fayetteville, North Carolina, Region 4. CERCLIS No. NCD003188844. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 19 Jul 1988. 7p. Available from NTIS, PC A02/MF A01.

The Carolina Transformer Company is on the National Priorities List. The 1.5-acre site, formerly an electrical transformer recycling operation, is located in a rural setting near East Fayetteville, North Carolina. Detection of polychlorinated biphenyls in soils and chlorobenzene in area groundwaters led to emergency removal of contaminated soils and the providing of alternative water supplies to some area residents. Contaminants of concern for the site included polychlorinated biphenyls and chlorobenzenes, and potentially other contaminants related to transformer oils. Based on the available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances.

24576 (PB–90-141854/XAB) **Health assessment for Celanese Fibers Operation (CFO) NPL (National Priorities List) Site, Shelby, Cleveland County, North Carolina, Region 4. CERCLIS No. NCD003446721. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 20 Jul 1988. 14p. Available from NTIS, PC A03/MF A01.

The Celanese Fibers Operation (CFO) is located nearly Shelby, Cleveland County, North Carolina. Contaminants of concern at

the site include benzene, trichloroethene (TCE), bis(2-ethylhexyl)phthalate, arsenic, and chromium. The major contaminant migration pathways are groundwater and soil. Contaminants in the groundwater, with the exception of TCE, reportedly have not reached private well supplies in the area. Approximately 475 people live within one mile of the site. Populations at special risk from contaminants found on the CFO site are children and the elderly. The Number 3 School, New Hope Church, and Children's Home are all located within one mile of the site. The CFO site, in its present state of contamination, does not pose an imminent public health risk; however, if contaminants found in the groundwater beneath the site reach the private wells in the area and are consumed, this exposure may cause a public health risk.

24577 (PB–90-141862/XAB) **Health assessment for Charles Macon Lagoon and Drum Storage, Cordova, Richmond County, North Carolina, Region 4. CERCLIS No. NCD980840409. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 27 Jul 1988. 7p. Available from NTIS, PC A02/MF A01.

The Charles Macon Lagoon and Drug Storage site is listed by the U.S. Environmental Protection Agency on the National Priorities List. The 16-acre site is an abandoned, hazardous waste storage facility that operated until 1981. The following materials were detected in the sludge removed from the site in 1983: barium, chromium, and creosote in sludge subsoil; 1,1,2,2-tetrachloroethane in sludge; and trichloroethylene, barium, chromium, 1,1-dichloroethane, and 1,1,2,2-tetrachloroethane in groundwater. Based on the available information, the site is considered to be of little public health concern due to the absence of exposure pathways to hazardous substances.

24578 (PB–90-141888/XAB) **Health assessment for Jadco-Hughes, Belmont, Gaston County, North Carolina, Region 4. CERCLIS No. NCD980729602. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 7 Jul 1988. 8p. Available from NTIS, PC A02/MF A01.

The Jadco-Hughes site is on the National Priorities List. From 1971 to 1975, C.A. Hughes operated a solvent reclamation and storage facility at the site. On-site contamination consists of 1,2-dichloroethane, barium, nickel, chromium, lead, and aluminum in surface water; and cadmium, chromium, lead, nickel, and polychlorinated biphenyls in sediment. Off-site contamination consists of 1,2-dichloroethane and barium in surface water, polychlorinated biphenyls and nickel in sediment. Based on the information available, the site is considered to be of potential public health concern due to the risk to human health caused by the possibility of exposure to hazardous substances via contaminated surface water, sediment, and groundwater.

24579 (PB–90-141896/XAB) **Health assessment for National Starch and Chemical Corporation (NSCC) Proposed NPL (National Priorities List) Site, Salisbury, Rowan County, North Carolina, Region 4. CERCLIS No. NCD991278953. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 13 Feb 1989. 21p. Available from NTIS, PC A03/MF A01.

The National Starch and Chemical Corporation is a proposed National Priorities List site located near the City of Salisbury, Rowan County, North Carolina. Past disposal of about 350,000 gallons of liquid wastes into trenches has introduced contamination into the groundwater and subsurface soils. The site-related contaminants include various volatile organic compounds (VOCs), bis(2-chloroethyl)ether, n-nitroso-diphenylamine, arsenic, selenium, and other heavy metals. Private well users may currently or in the future be impacted by the migration of on-site contaminants to off-site groundwater. The future migration of on-site contaminant plumes could also significantly affect the quality of the Grants Creek and its tributaries. Subsequently, the inhalation of volatilized VOCs from the creek water or the ingestion of consumable biota (e.g., livestock watered by creek water) potentially could become a human exposure pathway. The potential for contaminant migration in the groundwater is possible until remedial measures are completed.

24580 (PB–90-141904/XAB) **Health assessment for NC State University-lot 86, Raleigh, Wake County, North Carolina, Region 4. CERCLIS No. NCD980557656. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 2 Dec 1988. 8p. Available from NTIS, PC A02/MF A01.

The North Carolina State University-Lot 86 site is listed on the National Priorities List. The site consists of two separate and distinct areas which were used by the University to dispose of hazardous chemical waste and low-level radioactive waste generated in the educational and research laboratories from 1969 to 1980. The environmental contamination on-site consists of chloroform, ethylene dibromide, 1,1,2-trichloroethane, benzene, 1,2-dichloropropane, diethyl ether, 1,2-dibromomethane, and lead in groundwater. Other organic and inorganic chemicals of lesser toxicity or concentration are also present. Based on the available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contaminated groundwater.

24581 (PB–90-141920/XAB) **Health assessment for Carolawn Company, Fort Lawn, South Carolina, Region 4. CERCLIS No. SCD980558316. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 12 Apr 1989. 51p. Available from NTIS, PC A04/MF A01.

The Carolawn Company site, 4 kilometers west of Fort Lawn, South Carolina, is an abandoned waste storage and disposal facility on the United States Environmental Protection Agency's National Priorities List. Currently available data identify the presence of lead, benzene, and chlorinated aliphatic compounds in on-site and off-site groundwater. Contaminated groundwater was used for potable water by at least one household. Fishing Creek is a presumed groundwater discharge zone. Residences between the site and Fishing Creek are stated to be using a public water supply. Past sampling data of Fishing Creek have not indicated contamination. A Phase II Hydrogeologic Investigation is currently being performed. Public health considerations indicate the need for completion of site cleanup, monitoring of Fishing Creek for contamination, and abandonment of groundwater wells within the affected area (as per State regulations.)

24582 (PB–90-141946/XAB) **Health assessment for Golden Strip Septic Tank Service, Inc. Site, Simpsonville, South Carolina, Region 4. CERCLIS No. SCD980799456. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 29 Sep 1988. 7p. Available from NTIS, PC A02/MF A01.

The Golden Strip Septic Tank Service, Inc. Site is on the National Priorities List of the U.S. Environmental Protection Agency. It consists of five abandoned waste disposal lagoons covering 2 acres on a farm near Greenville, South Carolina. Environmental sampling to date indicates that the contaminants of concern are primarily heavy metals (e.g. chromium, cadmium, lead, and zinc) reaching from the lagoons into the groundwater. Sludge from one of the lagoons also contained 11,000 mg/kg cyanide. Based on the available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances.

24583 (PB–90-141961/XAB) **Health assessment for Kalama Specialty Chemicals, Burton, South Carolina, Region 4. CERCLIS No. SCD094995503. Preliminary report.** Nuclear Regulatory Commission, Washington, DC (USA). Div. of Water Reactor Safety. 12 Apr 1989. 9p. Available from NTIS, PC A02/MF A01.

The Kalama Specialty Chemicals (Kalama) 16-acre site is located in Beaufort County, South Carolina. The Vega Chemical Company operated at the site from 1973 until 1977. As a speciality chemical company, it produced a wide range of chemicals in small, special-order batches for use by manufacturing firms and larger chemical producers. In 1977, the facility was purchased by Kalama primarily to manufacture the herbicide and plant growth regulator Krenite (fosamine ammonium). Chemical sampling conducted at Kalama has been limited in scope. Lead, benzene, ethyl benzene, and dichloromethane have been among the detected on-site groundwater and soil contaminants. On the basis of available information, the Kalama site is considered to be of potential public health concern.

24584 (PB–90-141979/XAB) **Health assessment for Koppers Company Incorporated, Florence, South Carolina, Region**

4. CERCLIS No. SCD003353026. Final report. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Water Reactor Safety. 1 May 1989. 50p. Available from NTIS, PC A03/MF A01.

Koppers Company, Incorporated-Florence (KCI-F) is located in northeastern South Carolina near the city of Florence. KCI-F is on the U.S. Environmental Protection Agency's National Priorities List; KCI-F is also listed as a Resource Conservation Recovery Act facility. Available data identify pentachlorophenol (PCP), polycyclic aromatic hydrocarbons (PAHs), naphthalene, and phenols among the contaminants present in on-site and off-site groundwater. In addition to PCP, analyses of on-site soil borings demonstrated high levels of oil and grease. No surface soil assays were conducted. Known exposure pathways include ingestion, inhalation and dermal contact with contaminated groundwater and soil. Adverse health effects have been associated with some of the identified contaminants in the quantities reported in the preliminary data. However, more current and extensive sampling data of pertinent environmental media are needed to fully assess the public health implications of the site.

24585 (PB–90-141987/XAB) **Health assessment for Leonard Chemical Company, York County, Catawba, South Carolina, Region 4. CERCLIS No. SCD991279324. Preliminary report.** Nuclear Regulatory Commission, Washington, DC (USA). Div. of Water Reactor Safety. 10 Apr 1989. 13p. Available from NTIS, PC A03/MF A01.

The Leonard Chemical Company (LCC) site is listed by the U.S. Environmental Protection Agency on the National Priorities List. LCC was operated as a hazardous waste treatment facility from the late 1960s until 1982 when plant operations ceased under an Administrative Consent Order issued by the South Carolina Department of Health and Environmental Control (SCDHEC). As documented in a SCDHEC memorandum dated January 11, 1982, water samples from one of the houses near the southern border sampled in 1981 showed concentrations of iron and copper in excess of secondary drinking water standards, and the presence of volatile organics. The site is concluded to be of potential health concern because of the potential risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects.

24586 (PB–90-141995/XAB) **Health assessment for Medley Farms Site, Cherokee County, Gaffney, South Carolina, Region 4. CERCLIS No. SCD980558142. Preliminary report.** Nuclear Regulatory Commission, Washington, DC (USA). Div. of Water Reactor Safety. 14 Apr 1989. 9p. Available from NTIS, PC A02/MF A01.

The Medley Farms site is proposed for inclusion on the National Priorities List. The South Carolina Department of Health and Environmental Control (SCDHEC) had not permitted the use of the property for disposal of hazardous materials. Approximately 5,300 55-gallon drums and 15-gallon containers were discovered during an investigation by SCDHEC staff. After the Environmental Protection Agency's 1983 emergency clean-up activities, on-site groundwater samples were collected in 1984 and 1986. Contaminants found in these samples were as follows: methylene chloride, chloroform, carbon tetrachloride, 1,1-dichloroethane, 1,2-dichloroethane, 1,1,1-trichloroethane, 1,1,2-trichloroethane, 1,1-dichloroethylene, trans-1,2-dichloroethylene, and trichloroethylene. From the information reviewed, the site is concluded to be of potential health concern because of the possibility of human exposure to hazardous substances at concentrations which may result in adverse health effects.

24587 (PB–90-142001/XAB) **Health assessment for Palmetto Recycling, Inc., Columbia, South Carolina, Region 4. CERCLIS No. SCD037398120. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 29 Sep 1988. 7p. Available from NTIS, PC A02/MF A01.

The Palmetto Recycling, Inc. Site has been listed by the U.S. Environmental Protection Agency on the National Priorities List. Palmetto Recycling reclaimed lead, primarily from lead acid batteries, from 1979 to 1982. To date, identified contaminants of concern on the site include barium, cadmium, chromium, and lead in sediment; barium, cadmium, and chromium in drums and waste piles; and lead and mercury in drums. Groundwater sampling to date and analysis for conductivity, pH, and metals have shown limited contamination. Based on the available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances.

24588 (PB–90-142019/XAB) **Health assessment for Palmetto Wood Preserving, Dixiana, South Carolina, Region 4. CERCLIS No. SCD003362217. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 5 Jan 1987. 12p. Available from NTIS, PC A03/MF A01.

Portions of this document are not fully legible.

The Palmetto Wood Preserving Site, approximately five acres in size, was formerly used for treating wood and lumber. The chemicals used in the process, primarily chromium, copper, and arsenic compounds, were allowed to spill onto the ground. Sampling of the surface soil and the groundwater has shown these two media to be contaminated. The site is the location of a decommissioned wood preserving plant, which operated from 1963 until 1985. The five acre site is located in the rural community of Dixiana, in Lexington County. The site poses a potential health threat to children playing on the site and possibly to those using groundwater; however, only one private drinking water well has shown contamination at this time. EPA is continuing with the development of a feasibility study.

24589 (PB–90-142035/XAB) **Health assessment for Sangamo-Weston/12-Mile Creek/Lake Hartwell Site, Pickens County, South Carolina, Region 4. CERCLIS No. SCD003354412. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 30 Sep 1988. 8p. Available from NTIS, PC A02/MF A01.

The Sangamo-Weston/12-Mile Creek/Lake Hartwell Site has been listed on the National Priorities List. In 1975, polychlorinated biphenyl (PCB) disposal by and runoff from the Sangamo electroplating and manufacturing facility was discovered. PCB contamination has been identified in seven dumps, portions of Lake Hartwell, tributaries and the basin of the Twelve-Mile Creek, and essentially countywide. To date, sampling has shown PCBs in surface water, fish flesh, and soil and sediment. No information is available about physical hazards for the site. Based on the available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances.

24590 (PB–90-142043/XAB) **Health assessment for Scrdl - Bluff Road, Columbia, South Carolina, Region 4. CERCLIS No. SCD000622787. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

The Bluff Road Site (BRS) is in Columbia, South Carolina. Approximately 7,000 drums containing a wide variety of toxic, flammable and reactive wastes were removed from BRS. Preliminary on-site soil and groundwater sampling results have identified various metals, volatile organic compounds, and pesticides. Maximum concentrations found in pre-remediation groundwater sampling include trichlorofluoromethane, dieldrin, lead, and selenium. Based on available information, the site is considered to be of public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances.

24591 (PB–90-142084/XAB) **Health assessment for Amnicola Dump, Chattanooga, Tennessee, Region 4. CERCLIS No. TND980729172. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 7p. Available from NTIS, PC A02/MF A01.

Portions of this document are not fully legible.

The Amnicola Dump Site is a former municipal landfill located in Chattanooga (Hamilton County), Tennessee. The site is presently a scrap metal and salvage operation for railroad ties. Preliminary on-site sampling results have identified various volatile organic compounds. They include trichloroethylene, vinyl chloride, and trans-1,2-dichloroethylene. More recent on-site sampling results identified bis(2-ethylhexyl)phthalate, phenol, and 4-methyl phenol. Based on available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances.

24592 (PB–90-142100/XAB) **Health assessment for Mallory Capacitor Company, Waynesboro, Tennessee, Region 4. CERCLIS No. TND075453688. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 29 Sep 1988. 7p. Available from NTIS, PC A02/MF A01.

The Mallory Capacitor Company Site is listed on the National Priorities List. It is a former capacitor factory that has been closed since 1984 and is located on 8.5 acres in the small community of Waynesboro, Tennessee. Polychlorinated biphenyls and trichloroethylene have been found at the site. Based on the available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances.

24593 (PB–90-142118/XAB) **Health assessment for Milan Army Ammunition Plant, Milan, Carrol and Gibson Counties, Tennessee, Region 4. CERCLIS No. TND210020582. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 7p. Available from NTIS, PC A02/MF A01.

The Milan Army Ammunition Plant Site (MAAP) is located in Milan (Carrol and Gibson Counties), Tennessee. MAAP produces munitions for the U.S. Army. From 1942 to 1978 wastewater from a munition demilitarization process line was discharged into 11 unlined settling ponds. These ponds were dredged in 1971 with the soils placed near the side of the ponds. A multilayer cap was placed on top of the ponds and the dredged soils (1984). Access to the site is restricted. Removal actions have not occurred. Preliminary on-site groundwater sampling results have identified cyclonite (RDX), homocyclonite (HMX), 2,4,6-trinitrotoluene, 2,6-dinitrotoluene, 2,4-dinitrotoluene, 1,3,5-trinitrobenzene. In addition, cadmium, chromium, and lead were detected in on-site groundwater. Off-site surface water sampling results identified RDX and HMX. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances. Direct contact and ingestion with groundwater from on-site wells, off-site soils and bioaccumulation of site-related contaminants in fish, waterfowl, and crops with uptake from irrigation, and subsequent ingestion by area residents are possible human exposure pathways.

24594 (PB–90-142126/XAB) **Health assessment for Murray-Ohio, Lawrenceburg, Lawrence County, Tennessee, Region 4. CERCLIS No. TND980728836. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 2 Dec 1988. 8p. Available from NTIS, PC A02/MF A01.

The Murray-Ohio site is listed on the National Priorities List. The approximately 27-acre site, of which approximately six acres contain buried wastes, was an industrial landfill that accepted paint and electroplating sludges from 1963 until 1982. The environmental contamination on-site consists of hexavalent chromium, total chromium, nickel, zinc, lead, and cadmium in soil; and hexavalent chromium, total chromium, nickel, zinc, lead, and cadmium in groundwater. Based on the available information, the site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contaminated groundwater, sediment, and surface water.

24595 (PB–90-142142/XAB) **Health assessment for Velsicol Chemical Company, Toone, Tennessee, Region 4. CERCLIS No. TND980559033. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 4 Nov 1988. 7p. Available from NTIS, PC A02/MF A01.

The Hardeman County Landfill site is listed on the National Priorities List. Velsicol Corporation used 242 acres of the land for disposal of off-specification pesticides and other related compounds beginning in 1964. Specific information on the environmental contamination on-site consisted of a reference to the probable theory that these chemicals consisted of a multitude of pesticide compounds (endrin, heptachlor, chlordanes, aldrin, dieldrin, hexachlorocyclopentadiene, hexachlorobenzene, and others), chlorinated benzenes, chlorinated phenols, and other chemicals. Environmental media-specific data were not provided. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contaminated groundwater and soil.

24596 (PB–90-142902/XAB) **Determination of polychlorinated biphenyls using multiple regression with outlier detection and elimination.** Burkhard, L.P.; Wininger, D. Wisconsin Univ., Superior, WI (USA). Center for Lake Superior Environmental Studies. c 1987. 7p. Available from NTIS, PC A02/MF A01.

Pub. in Analytical Chemistry 59, 1187-1190(1987).

A method for the analysis of capillary column polychlorinated biphenyl (PCB) data using regression analysis with outlier checking and elimination, COMSTAR, is presented and evaluated. The algorithm determines the best combination of the commercial PCB mixtures which best fits the chromatographic fingerprint of the sample by excluding weathered and contaminated PCB components from its final determination. Subsequently, significance testing on the final determination is performed. The extra sum of squares test is used for outlier testing. The chief advantage of COMSTAR over other PCB analysis methods is its ability to discern more accurately the amount of PCB present in a sample when weathered and contaminated or enriched PCB components exist in the chromatographic data.

24597 (PB–90-143553/XAB) **Health assessment for Sand, Gravel and Stone, Elkton, Maryland, Region 3. CERCLIS No. MDD980705099. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 2 Feb 1989. 15p. Available from NTIS, PC A03/MF A01.

The Sand, Gravel and Stone site is located near Elkton in Cecil County, Maryland. It was reported that 3 acres of the northeast portion of the site were used for disposal of waste processing water, sludge, still bottoms, 90 drums of solid and semi-solid waste, and 700,000 gallons of wastes. Sampling identified wastes, predominantly in solid and semisolid form, containing acetone, benzene, bis(2-ethylhexyl)phthalate, butylbenzylphthalate, chlorobenzene, chloroform, diethylphthalate, di-n-butylphthalate, ethylbenzene, 1,1,1-trichloroethane, and xylenes. Concentrations of heavy metals, pesticides, and volatile organic compounds (VOCs), exceeding USEPA Drinking Water Standards/Health Advisory Levels, were reported in the surface water on-site. Concentrations of heavy metals, pesticides, and VOCs were found in sediments. The shallow groundwater aquifer contained heavy metals and VOCs at concentrations above USEPA Drinking Water Standard levels. Lead concentrations measured in the deep groundwater aquifer were substantially above the USEPA proposed Maximum Contaminant Level for drinking water. In addition, several VOCs were detected, but at concentrations below their respective drinking water limits. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances. Potential environmental pathways include those related to human exposure to contaminated soil, sludge, surface water, groundwater, air, and the food chain.

24598 (PB–90-143579/XAB) **Health assessment for Commodore Semiconductor Site, Norristown, Pennsylvania, Region 3. CERCLIS No. PAD093730174. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 29 Sep 1988. 7p. Available from NTIS, PC A02/MF A01.

The Commodore Semiconductor Site, located in a residential and light-industrial area in Norristown, Pennsylvania, is an active computer chip manufacturing facility with a history of leaking underground solvent storage tanks. On-site groundwater is contaminated with high levels of trichloroethylene (TCE) and other volatile organic compounds (VOCs) including trans-dichloroethylene, benzene, chloroform, methylene chloride, carbon tetrachloride, and tetrachloroethylene. On-site soils have been sampled on at least one occasion in 1979, and TCE was found at a concentration of 8,840 ppm. An air stripper has been in operation since 1984, but no ambient air data were supplied. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances if the aquifer were to be used as a primary water supply by nearby residents. On-site soils should be better characterized and access limited for those areas found to be highly contaminated at this active facility.

24599 (PB–90-143587/XAB) **Health assessment for Centre County Kepone, State College, Centre County, Pennsylvania, Region 3. CERCLIS No. PAD000436261. Preliminary report.**

Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 2 Dec 1988. 7p. Available from NTIS, PC A02/MF A01.

The Centre County Kepone site is an active chemical manufacturing plant that produced Kepone and Mirex from the 1950s until the 1970s. Wastes were stored in a lagoon and drum storage area. The lagoon waste was chemically stabilized and buried. However, the waste did not solidify properly, and hazardous materials presently are leaching into the groundwater and surface water. The environmental contamination on-site consists of toxaphene, trichloroethylene, benzene, chlorobenzene, carbon tetrachloride, and chrysene in groundwater; and polynuclear aromatic hydrocarbons, including benzo(a)pyrene in sediment. The environmental contamination off-site consists of benzene, chlorobenzene, dichloroethane, trichloroethylene, and tetrachloroethane in surface water; chrysene in drainage ditch sediment; and tetrachloroethylene in groundwater. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contaminated groundwater, surface water, sediment, soil, and fish.

24600 (PB–90-143595/XAB) **Health assessment for C and D Recycling, Foster Township, Luzerne County, Pennsylvania, Region 3. CERCLIS No. PAD021449244. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 15 Nov 1988. 8p. Available from NTIS, PC A02/MF A01.

The C&D Recycling 45-acre site was used during the early 1960s until 1984 as a secondary lead smelter, incinerating lead- and plastic-cased telephone cables to recycle copper. Plastic coverings were mechanically stripped prior to incineration, and were stored on-site in piles. The environmental contamination on-site consists of lead and copper in remaining ash piles; lead and copper in soil; lead and cadmium in shallow groundwater; pentachlorophenol, toluene, and lead in deeper groundwater; and lead and copper in surface water. The environmental contamination off-site consists of lead in soil; and lead and copper in residential wells. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contaminated groundwater. This conclusion is based on the fact that groundwater already is significantly impacted. Surface water, soil, sediment, and airborne particulates may also become significant pathways in the erosion/migration of contaminants off-site, which may lead to unacceptable concentrations in off-site environmental media.

24601 (PB–90-143629/XAB) **Health assessment for Brown's Battery Breaking Site (Sshaner), Tilden Township, Berks County, Pennsylvania, Region 3. CERCLIS No. PAD980831812. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 14 Nov 1988. 8p. Available from NTIS, PC A02/MF A01.

The Brown's Battery Breaking Site is on the National Priorities List. The approximately thirteen-acre site is an abandoned battery processing facility which was in operation from 1961 to 1977. The environmental contamination on-site consisted of nickel, lead, and zinc in surface soil, and lead in surface water. Samples from the private wells on-site did not show contamination. However, an unfiltered groundwater sample from an auger hole in a sampling pit had 17.5 ppm lead. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via consumption of contaminated groundwater and aquatic organisms.

24602 (PB–90-143645/XAB) **Health assessment for Blosenski Landfill National Priorities List (NPL) Site, West Caln Township, Chester County, Pennsylvania, Region 3. CERCLIS No. PAD980539985. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 23p. Available from NTIS, PC A03/MF A01.

The Blosenski Landfill National Priorities List site is in West Caln Township, Chester County, Pennsylvania. Industrial and municipal wastes that contain organic compounds and heavy metals have been disposed of on the property. The site is of potential health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects. Contaminants, principally volatile organic compounds, have been detected at levels of potential concern in groundwater on-site and off-site, in soils on-site, in some water supply wells, and in surface water and sediments in a tributary that receives runoff from the area. Groundwater is the principal contaminated medium of concern. A temporary alternate water supply has been provided to two residences, and a permanent alternate water supply is being developed for these parties and for any other groundwater users where monitoring indicates the groundwater supply may be contaminated.

24603 (PB–90-143652/XAB) **Health assessment for Berks Sand Pit National Priorities List (NPL) Site, Longswamp Township, Pennsylvania, Region 3. CERCLIS No. PAD980691794. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 18 Jan 1989. 9p. Available from NTIS, PC A02/MF A01.

The Berks Sand Pit National Priorities List site is located in Longswamp Township, Pennsylvania. Originally sand and gravel was mined at the site. The site was then used for the disposal of refuse by the area residents. Industrial waste was allegedly disposed in the pit area. The pit was backfilled; houses and private wells were constructed at the site in 1978. Groundwater contamination was detected in the area by the residents in 1982. Contaminants of concern are 1,1,1-trichloroethane and 1,1-dichloroethene. Both contaminants were also detected in the tributary of the West Branch of Perkiomen Creek to the east of the site. Soil, sediment, and air sampling results showed no contamination of health concern. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances in the groundwater and surface water.

24604 (PB–90-143660/XAB) **Health assessment for New Castle Steel National Priorities List (NPL) Site, New Castle, New Castle County, Delaware, Region 3. CERCLIS No. DED980705255. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 17 Apr 1989. 14p. Available from NTIS, PC A03/MF A01.

The New Castle site, located in the City of New Castle, New Castle County, Delaware, is an inactive landfill that had received foundry wastes containing metals. The site is of potential health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects. Contaminants released from the site have entered groundwater, soils, sediments, and surface waters. Frequent or prolonged exposure to contaminants in marsh surface water and sediments or in consumable aquatic biota would increase the risk of adverse health effects. However, frequent or prolonged exposures are unlikely in this marsh setting. Therefore, it is not expected that adverse health effects would actually occur. The proposed cap should effectively minimize the potential for airborne contaminant releases on-site and for direct contact with contaminants on-site, and should reduce releases to groundwater and surface water. However, the on-site remediation will not reduce the existing contaminant concentrations in marsh sediments.

24605 (PB–90-143686/XAB) **Health assessment for National Cash Register Corporation, Millsboro, Delaware, Region 3. CERCLIS No. DED043958388s. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 19 Jul 1988. 8p. Available from NTIS, PC A02/MF A01.

The NCR Corporation (First Freedom Center) site began in 1967 as manufacturing facility for mechanical cash registers and electronic calculating equipment, entailing one unlined pit, three cement-lined storage lagoons, and a waste water treatment plant. The environmental contamination on-site consists of heavy metals (chromium and lead) and chlorinated solvents (tetrachloroethylene and 1,2-dichloroethylene) in groundwater; heavy metals (chromium, lead, mercury, copper, and zinc) and chlorinated solvents (trichloroethylene) in soil. Off-site contamination consists of chlorinated solvents in soil (1,1,1-trichloroethylene and trichloroethylene), surface water (trichloroethylene) and groundwater (trichloroethylene). In addition, fish have been found to be contaminated with trichloroethylene. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contaminated

groundwater, surface water, and possibility through contamination of the aquatic food chain.

24606 (PB–90-143694/XAB) **Health assessment for Harvey and Knott Drum National Priorities List (NPL) Site, New Castle County, Delaware, Region 3. CERCLIS No. DED980713093. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 21p. Available from NTIS, PC A03/MF A01.

The Harvey & Knott Drum National Priorities List site, located near Kirkwood in New Castle County, Delaware, is an inactive landfill that had received sanitary, municipal and industrial wastes. Contaminants released from the site include heavy metals and organic compounds and have entered groundwater, soils, sediments, and surface waters. The principal concern is that contaminated groundwater may migrate to off-site domestic, public, and agricultural water supply wells. Also, contaminants in off-site surface water and sediments pose some concern for recreational use and consumption of fish. Off-site contaminated soils near the west property line may be a threat to persons that trespass into that area. The site is of potential health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects.

24607 (PB–90-143702/XAB) **Health assessment for Halby Chemical, Wilmington, Delaware, Region 3. CERCLIS No. DED980830954. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 4 Jan 1989. 8p. Available from NTIS, PC A02/MF A01.

The Halby Chemical Site is located in southeastern Wilmington (New Castle County), Delaware. Some of the drums from a storage area encompassing approximately 20,000 square feet, were found to be leaking. In addition, a lagoon exists on-site that was used for waste disposal. Preliminary on-site groundwater sampling results have identified cyanide (or thiocyanate), tetrachloroethane, iron, and manganese. In addition, arsenic, lead, cadmium, and mercury were identified in aqueous samples from the lagoon. Cyanide was also detected in soil. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances. Direct contact with and possible ingestion of contaminated sediment and surface water are the human exposure pathways of concern.

24608 (PB–90-143710/XAB) **Health assessment for E. I. Dupont Newport Plant Landfill, Newport, Delaware, Region 3. CERCLIS No. DED980555122. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 11 May 1988. 7p. Available from NTIS, PC A02/MF A01.

The E.I. Dupont Newport Plant Landfill, a seven acre site located adjacent to the Dupont Pigment Plant in Newport, Delaware, was used to bury paint pigments (heavy metals and chlorinated solvents) and radioactive materials from 1902 to 1975. The site was closed in 1975, the surface covered, graded and vegetated, and groundwater monitoring wells installed on- and off-site. Heavy metals (cadmium, barium, lead, zinc), and chlorinated solvents (trichloroethylene, tetrachloroethylene) have been measured in groundwater on-site. Radiation levels appear to be close to background. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via groundwater. More information is needed concerning levels of contamination in private wells and the Christina River, the direction of groundwater flow, the size and extent of the groundwater contamination plume, the location of the private wells and the public water supply wells, and the composition of the population down gradient of the site.

24609 (PB–90-143736/XAB) **Health assessment for Dover Air Force Base, Dover, Delaware, Region 3. CERCLIS No. DE8570024010. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 20 Jan 1989. 8p. Available from NTIS, PC A02/MF A01.

The Dover Air Force Base (DAF) 11-acre site is a government-owned, government-operated facility located in Dover (Kent County), Delaware. DAF contains 13 areas on-site that were used for disposing of industrial waste. Preliminary on-site sampling results have demonstrated heavy metal contamination in sludge, sediment and surface water. In particular mercury, chromium, and cadmium have been reported in on-site surface water. Sampling results have demonstrated volatile organic compounds (VOCs) present in sediment. In addition, on-site groundwater sampling results demonstrated arsenic, cadmium, perchloroethylene, and trichloroethylene. Off-site groundwater sampling identified a variety of VOCs present in well water. In particular, TCE and carbon tetrachloride were two of the major VOCs demonstrated in off-site groundwater. The site is considered to be of public health concern because of the risk to human health caused by the likelihood of human exposure to hazardous substances. Area residents may risk exposure through the use of contaminated groundwater for potable purposes, and ingest fish and wildlife that bioaccumulate site related contaminants.

24610 (PB–90-143744/XAB) **Health assessment for Delaware Sand and Gravel Landfill National Priorities List (NPL) Site, New Castle County, Delaware, Region 3. CERCLIS No. DED000605972. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 20 Apr 1989. 19p. Available from NTIS, PC A03/MF A01.

The Delaware Sand & Gravel Landfill National Priority List site is in New Castle County, Delaware. The property is adjacent to the Army Creek Landfill NPL site, and remedial planning for both sites is being coordinated so that corrective measures are compatible and effective. Contaminants of principal concern are volatile organic compounds and heavy metals. The principal potential public health concern is for contaminated groundwater and its effect on a public water supply well field downgradient from the landfill sites. A groundwater recovery system, to date, has prevented potentially extensive contamination of the public water supply (well field); proposed remedial measures are expected to improve groundwater quality. The site, without remediation, is of potential health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects.

24611 (PB–90-143751/XAB) **Health assessment for Delaware City PVC (polyvinyl chloride) Plant NPL (National Priorities List) Site, New Castle County, Delaware, Region 3. CERCLIS No. DED980551667. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 18 Apr 1989. 16p. Available from NTIS, PC A03/MF A01.

The Delaware City PVC Plant site is located in New Castle County, Delaware, near Delaware City. Stauffer Chemical Company and Formosa Plastics Company operate facilities on the property. Volatile organic compounds have been detected in groundwater on- and off-site and in soils on-site. Groundwater is used for water supply at residences and businesses in the site vicinity. The concentrations of volatile organic compounds recorded on-site in water-supply wells and monitoring wells exceed regulatory limits. An alternate water supply has been provided to residences on- and off-site and to off-site businesses where contaminants have been detected in water-supply wells. Remediation has been initiated for contaminant sources on-site and for groundwater quality. The site is of potential public health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects.

24612 (PB–90-143769/XAB) **Health assessment for Millcreek National Priorities List (NPL) Site, Millcreek Township, Erie County, Pennsylvania, Region 3. CERCLIS No. PAD980231690. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 30 Jun 1989. 30p. Available from NTIS, PC A03/MF A01.

The Millcreek National Priorities List Site is located in Millcreek Township, Erie County, Pennsylvania. Industrial and municipal wastes containing volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs) and heavy metals have been disposed on the property. The site is of potential health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects. Contaminants, principally VOCs and metals, have been detected at levels of potential concern in groundwater on-site and off-site. Surface and subsurface soils, surface water, and sediments also are contaminated. Groundwater is the principal

environmental medium of concern because, under extended drought conditions, contaminated groundwater might migrate to an upgradient public water supply well field.

24613 (PB–90-143777/XAB) **Health assessment for Middletown Air Field, Middletown, Pennsylvania, Region 3. CERCLIS No. PAD980538763. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). Apr 1988. 14p. Available from NTIS, PC A03/MF A01.

The Middletown Air Field is located southeast of Harrisburg, Pennsylvania. Past waste disposal activities at the Middletown Air Field have resulted in contamination of the groundwater aquifer with trichloroethylene (TCE), tetrachloroethylene (PCE), and other volatile organic chemicals (VOCs). Since 1983, the selective pumping of wells and periodic monitoring of water from the wells and distribution system have maintained VOC concentrations in finished water below acceptable health-based values. It is not possible to assess potential health effects that may have resulted from exposure to VOCs in potable water prior to 1983 because of the lack of data. Additional studies are needed to determine whether there is any human exposure to contamination sources from private potable wells or through other routes of exposure.

24614 (PB–90-143785/XAB) **Health assessment for Metal Bank, Philadelphia, Pennsylvania, Region 3. CERCLIS No. PAD046557096. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 17 Mar 1989. 7p. Available from NTIS, PC A02/MF A01.

The Metal Bank Site (MBS) is on the National Priorities List. MBS was reported to be used as a waste disposal area for solid waste. Preliminary on-site soil sampling results have identified PCBs. PCBs have also been identified in groundwater and biota (not specified). Off-site surface water sampling of the oil slick in the Delaware River identified PCBs. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances.

24615 (PB–90-143793/XAB) **Health assessment for Malvern Trichloroethylene, Malvern, Pennsylvania, Region 3. CERCLIS No. PAD014353445. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 19 Jan 1989. 8p. Available from NTIS, PC A02/MF A01.

The Malvern Trichloroethylene (TCE) Site (MTS) is in Malvern(Chester County) Pennsylvania. From 1952 to 1976 drums containing various wastes including volatile organic compounds and PCBs were dumped on-site. Preliminary on-site groundwater sampling results have identified TCE (ND to 1,330 ppm), perchloroethylene (PCE) (7 to 1,170 ppm), 1,1,1-trichloroethane (TCA) (12 to 2,230 ppm), and tetrachloroethylene (ND to 22,000 ppb). In addition, PCBs were identified in soil (1,350 ppm) and in drums. The site is considered to be of public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances.

24616 (PB–90-143819/XAB) **Health assessment for Lord Shope Landfill National Priorities List (NPL) Site, Erie, Erie County, Pennsylvania, Region 3. CERCLIS No. PAD980508931. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 19p. Available from NTIS, PC A03/MF A01.

The Lord Shope Landfill site is located in Erie, Erie County, Pennsylvania. Long-term ingestion exposure to lead in private drinking water wells and long-term dermal contact exposure to arsenic in off-site surface water are of public health concern. The absence of adequate background sampling data makes it impossible to determine if these contaminants are attributable to the site. The site is of public health concern because of the risk to human health resulting from probable exposure to hazardous substances at concentrations that may result in adverse human health effects.

24617 (PB–90-143835/XAB) **Health assessment for Wildcat Landfill (WLF) National Priorities List (NPL) Site, Kent County, Delaware, Region 3. CERCLIS No. DED980704951. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 7 Feb 1989. 19p. Available from NTIS, PC A03/MF A01.

The Wildcat Landfill (WLF) is located in Kent County, Delaware. The site was operated as a sanitary landfill between 1962 and 1973, accepting both municipal and industrial wastes. Although sampling and analysis of on-site and off-site groundwater, surface water, leachate, sediments, and soil revealed a number of contaminants, including volatile organic compounds (VOCs), polychlorinated biphenyls, arsenic, and manganese, the highest levels of contaminants were found in off-site areas east of the St. Jones River, indicating the possibility of influence from a separate contaminant source. The major components of the landfill Record of Decision include: institutional restrictions on development of the site and the installation of potable supply wells on-site and areas adjacent to the site, grading, covering with soil, and revegetating on-site areas; removal and disposal of drums; and replacement of two domestic wells adjacent to the site. Until remedial actions are complete, there is a potential public health threat from dermal absorption or ingestion of contaminated groundwater, leachate, surface water, soil, and sediments, and the inhalation of VOCs and fugitive dusts.

24618 (PB–90-143843/XAB) **Health assessment for Aberdeen Proving Grounds, Aberdeen, Maryland, Region 3. CERCLIS Nos. MD3210021355 and MD10020036. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 19 Jan 1989. 8p. Available from NTIS, PC A02/MF A01.

The Aberdeen Proving Grounds site is located in Aberdeen (Harford County) Maryland. Preliminary on-site groundwater and surface water sampling results have identified various metals, phosphorus, and volatile organic compounds. They include: 1,2-dichloroethylene, chloroform, 1,2-dichloroethane, trichloroethylene, benzene, 1,1,2,2-tetrachloroethane, tetrachloroethylene, 1,4-dithiane and 1,2-dichloroethylene. In addition, it has been reported that among the substances disposed of on-site are significant quantities of toxic metals, cyanide compounds, phosphorus, phosgene, napalm, and mustard gas. The site is considered to be of public health concern because of the risk to human health caused by the likelihood of human exposure to hazardous substances. Potential environmental pathways include those related to contaminated groundwater, surface water, on-site soils, and volatilization of contaminants in ambient air.

24619 (PB–90-143868/XAB) **Health assessment for Limestone Road, Cumberland, Maryland, Region 3. CERCLIS No. MDD980691588. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 23 Oct 1986. 10p. Available from NTIS, PC A02/MF A01.

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The Limestone Road Site in Allegany County, Maryland consists of 210 acres. The primary concerns for the site are groundwater contamination, possibly evidenced by the levels of lead in three wells in the area, surface and sediment contamination from runoff of contaminated soil from the site, on-site surface and subsurface contamination. The surface soil showed elevated levels of arsenic, cyanide, and benzo(a)pyrene. The fly ash contained elevated levels of arsenic and chromium. The samples from the leachate seep area also contained elevated levels of arsenic and chromium. Sediment samples showed elevated levels of cadmium and arsenic. Wells contained lead in excess of the EPA drinking water standard. Subsurface soil samples contained elevated concentrations of arsenic and chromium.

24620 (PB–90-143876/XAB) **Health assessment for Mid-Atlantic Wood Preserver, Harmans, Ann Arundel County, Maryland, Region 3. CERCLIS No. MDD064882889. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 2 Dec 1988. 8p. Available from NTIS, PC A02/MF A01.

The Mid-Atlantic Wood Preserver site is on the National Priorities List. The three-acre site is a wood treatment facility that uses the chromated copper arsenate process to protect lumber from water and insects. The environmental contamination on-site consists of arsenic and chromium in groundwater monitoring wells; and arsenic and chromium in soil. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via consumption of contaminated groundwater.

24621 (PB–90-143884/XAB) **Health assessment for Middletown Road Dump, Anne Arundel County, Annapolis, Maryland, Region 3. CERCLIS No. MDD980705099. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 1990. 9p. Available from NTIS, PC A02/MF A01.

The Middletown Road Site is a National Priorities List Site located near Annapolis, Anne Arundel County, Maryland. The contaminants found at the site before the emergency cleanup in 1983 were a variety of metals and organics (phenolic compounds, chlorinated compounds and base/neutral extractable compounds). After the cleanup, only minimal concentrations of contaminants remain on the site. The remedial alternative selected in the March 1986 Record of Decision is no action with regard to further remediation of the site. This option was selected because the Remedial Investigation confirmed the completeness of the emergency action.

24622 (PB–90-143892/XAB) **Health assessment for Saunders Supply Company, Chuckatuck, Virginia, Region 3. CERCLIS No. VAD003117389. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 1 Dec 1988. 7p. Available from NTIS, PC A02/MF A01.

The Saunders Supply Company (SSC) is an active wood treating facility encompassing 3.5 acres in Chuckatuck (Suffolk County), Virginia. Waste sludge from the wood-treating operation was burned on-site and has contaminated groundwater. On-site contaminants of concern include pentachlorophenol (PCP), dioxins and furans, chromium and arsenic. Site-related contaminants have been detected in a surface reservoir that serves Suffolk City. Off-site contaminants of concern included chromium, arsenic, lead, and aluminum. There is a potential for human exposure from site-related contaminants both on-site and off-site. On-site soil contain concentrations of PCP, PAHs, total dioxins and furans, and TCDD equivalents that are of potential health concern. Groundwater is another exposure pathway that poses a potential public health threat. Surface water sampling results from the reservoir have demonstrated lead and chromium at levels of health concern. However, finished water from the reservoir were well below the Maximum Contaminant Levels, according to the superintendent of Suffolk Water Treatment Plant.

24623 (PB–90-143900/XAB) **Health assessment for US Titanium Site, Piney River, Amherst and Nelson County, Virginia, Region 3. CERCLIS No. VAD980705404. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 19 Jan 1989. 8p. Available from NTIS, PC A02/MF A01.

The U.S. Titanium site is an abandoned mining and ore processing plant. The environmental contamination on-site consists of manganese (1,00 ppm), iron (5,570 ppm), nickel (6.3 ppm), zinc (12 ppm), and sulfates (1.8 percent) in groundwater; and iron (496,000 ppm) in surface waste. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via surface water, dermal contact with seeps, and ingestion of contaminated fish.

24624 (PB–90-143942/XAB) **Health assessment for Mobay Chemical Corporation, New Martinsville, West Virginia, Region 3. CERCLIS No. WVD056866312. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 20 Jan 1989. 8p. Available from NTIS, PC A02/MF A01.

The Mobay Chemical Corporation Site (MCC) manufactures various organic compounds including polycarbonates and toluene diisocyanate and ferrous oxide pigments. Hazardous wastes have been disposed of on-site in landfills and lagoons. On-site sampling results have identified volatile organic compounds (VOCs in groundwater.) They include: vinyl chloride (trace to 10 ppb), trans-1,2-dichloroethylene (trace amounts), chlorinated benzenes (130 to 7,700 ppb), ethylbenzene (120 ppb), acetone (trace to 10,000 ppb), phthalates (trace to 130 ppb), and toluene (trace to 1,300 ppb). The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances via contaminated groundwater.

24625 (PB–90-143959/XAB) **Health assessment for Ordinance Works National Priorities List (NPL) Site, Monongalia County, West Virginia, Region 3. CERCLIS No. WVD060850404. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 23p. Available from NTIS, PC A03/MF A01.

The Ordinance Works is located south of Morgantown, West Virginia. The site soils are heavily contaminated with various metals, cyanide, polyaromatic hydrocarbon compounds (PAHs), and, to a lesser degree, polychlorinated biphenyls(PCBs). Site groundwater does not appear to be significantly contaminated, although one area needs further characterization. There is no indication that human exposure to site-related contaminants is currently occurring. However, the potential exists for exposure of area residents to contaminated groundwater, surface water, and consumable biota.

24626 (PB–90-143967/XAB) **Health assessment for Army Creek Landfill National Priorities List (NPL) Site, New Castle County, Delaware, Region 3. CERCLIS No. DED980494496. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 20 Apr 1989. 18p. Available from NTIS, PC A03/MF A01.

The Army Creek Landfill NPL site is located in New Castle County, Delaware. Volatile organic compounds and heavy metals in groundwater are the principle contaminants of public health concern. The site, without remediation, may be of potential health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects.

24627 (PB–90-143975/XAB) **Health assessment for Chem-Solv, Inc., Cheswold, Delaware, Region 3. CERCLIS No. DED980714141. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 29 Sep 1988. 7p. Available from NTIS, PC A02/MF A01.

The Chem-Solv site is on the National Priorities List. The on-site groundwater is contaminated with volatile organic chemicals (VOCs) including trichloroethylene and 1,1,1-trichloroethane. One off-site residential well was found to contain 1,2-dichloropropane. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via media which have not yet been characterized completely or at all.

24628 (PB–90-143983/XAB) **Health assessment for Coker's Sanitation Service Landfills, Cheswold, Delaware, Region 3. CERCLIS No. DED980704860. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 14 Nov 1988. 7p. Available from NTIS, PC A02/MF A01.

The Coker's Sanitation Service Landfills site is the location of two former landfills used to dispose of latex rubber waste sludges from what is now the Reichhold Chemicals, Inc. plant. On-site contamination consists of ethylbenzene, iron, toluene, acrolein, and bis-2-chloroethylether in groundwater, waste sludges, sediments, and leachate. Off-site sampling of monitoring wells indicates acrolein and ethylbenzene in groundwater. There are no reports of physical hazards at the site. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via groundwater.

24629 (PB–144007/XAB) **Health assessment for Havertown PCP, Havertown, Pennsylvania, Region 3. CERCLIS No. PAD0023338010. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 26 Nov 1985. 10p. Available from NTIS, PC A02/MF A01.

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National Wood Preservers reportedly disposed of one million gallons of pentachlorophenol sludge in a shallow well on-site. Environmental Protection Agency (EPA) sampling of surface water, into which discharges a sewer pipe that intercepts the contamination plume, found less than 0.6 ppm pentachlorophenol. It is the Agency for Toxic Substances and Disease Registry's opinion that this concentration of pentachlorophenol in water does not present any human health hazard.

24630 (PB–90-144015/XAB) **Health assessment for Hebelka Site, Weisenber Township, Lehigh County, Pennsylvania, Region 3. CERCLIS No. PAD980829329. Preliminary report.**

Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 14 Apr 1989. 13p. Available from NTIS, PC A03/MF A01.

The Hebelka Site in Weisenber Township, Lehigh County, Pennsylvania, has been used for the disposal of about 1,000 cubic yards of battery waste on-site. In addition, automobiles, empty storage tanks, empty drums, and miscellaneous scrap metals are disposed of on-site. Lead is the major contaminant of concern related to the Hebelka site; however, several other heavy metals were found in ground water at concentrations of public health concern. Based on current monitoring data, these other heavy metals found in ground water (except lead) were not found in the on-site soils at concentrations of public health concern. The site is of public health concern because of the risk to human health resulting from probable exposure to hazardous substances at concentrations that may result in adverse human health effects. Human exposure to lead and other metals is probably occurring and has probably occurred via oral (ingestion), dermal, and inhalation exposure to groundwater by users of private residential well water. Exposure to surface soils, low pH waste material, and physical hazards may occur to by on-site trespassers and workers.

24631 (PB–90-144023/XAB) **Health assessment for Heleva Landfill National Priorities List (NPL) Site, North Whitehall Township, Lehigh County, Pennsylvania, Region 3. CERCLIS No. PAD980537716. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 17 Apr 1989. 26p. Available from NTIS, PC A03/MF A01.

The Heleva Landfill site is in North Whitehall Township, Lehigh County, Pennsylvania. The site has operated as a sanitary landfill and accepted undetermined types and amounts of industrial wastes including solvents. Wastes were deposited in and around two abandoned mining pits. The site is of public health concern because of the risk to human health resulting from probable exposure to hazardous substances at concentrations that may result in adverse human health effects through ingestion, inhalation, or dermal contact. Contaminants, principally volatile organic compounds (VOCs), have been detected at levels of potential concern in groundwater off-site, in some water supply wells, in air, and in surface water. Groundwater is the principal contaminated medium of concern. Human exposure to VOCs and lead is currently occurring via groundwater at some of the area residential groundwater supply wells through ingestion, inhalation, and dermal contact. The public water system is being extended to these residents and other potentially affected groundwater users.

24632 (PB–90-144031/XAB) **Health assessment for Hellertown Manufacturing, Hellertown, Pennsylvania, Region 3. CERCLIS No. PAD002390748. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 29 Sep 1988. 7p. Available from NTIS, PC A02/MF A01.

The Hellertown Manufacturing Site (HMS) is a former spark plug manufacturing facility located in Hellertown (Northampton), Pennsylvania. Between 1930 and 1976, the HMS operated a series of five unlined lagoons that were used for the disposal of zinc and chromium plating wastes and cleaners, and cutting oil water generated by the facility. The five lagoons were closed out in 1976 by backfilling with the waste sludges remaining in the lagoons. On-site contaminants of concern include chromium and cyanide from sludge lagoons. ATSDR is unable to determine the potential public health threat to area residents based on the limited amount of sampling performed. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substance via direct contact and possibly through inhalation. ATSDR is unable to comment on other potential human exposure pathways without additional on-site soil sampling and off-site soil, groundwater, and surface water information.

24633 (PB–90-144049/XAB) **Health assessment for Henderson Road National Priorities List (NPL) Site, Upper Merion Township, Montgomery County, Pennsylvania, Region 3. CERCLIS No. PAD009862939. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 18 Oct 1988. 14p. Available from NTIS, PC A03/MF A01.

The 8-acre Henderson Road National Priorities List site is located in Upper Merion Township, Montgomery County, Pennsylvania. The injection well was used to dispose of industrial wastes during the 1970s. Various volatile organic compounds and phthalate compounds were detected in the well. The primary environmental pathway of concern related to this operable unit is groundwater. The primary potential human exposure pathway is ingestion of contaminated groundwater. Current and future private well users and users of the McIlvain Well are the primary potential receptors of concern. Other human exposure pathways of concern are possible inhalation of volatilized contaminants and direct dermal contact with contaminated groundwater during indoor water use by off-site groundwater users.

24634 (PB–90-144056/XAB) **Health assessment for Hranica Landfill, Sarver, Butler County, Pennsylvania, Region 3. CERCLIS No. PAD980508618. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 14 Nov 1988. 8p. Available from NTIS, PC A02/MF A01.

The Hranica Landfill 15-acre site is the location of a landfill, drum disposal, and waste incineration facility which operated from 1966 to 1974. In 1984, a private party removal action took place which resulted in the removal of approximately 19,000 drums of contaminated materials and the top six inches of the most heavily contaminated soil. The environmental contamination remaining on-site after the 1984 removal and cleanup consists of mercury, arsenic, phenols, polychlorinated biphenyls, trichloroethylene, and benzene in soil; and arsenic, cadmium, chromium, lead, ethylbenzene, methylene chloride, benzene, and xylene in groundwater. Environmental contamination off-site consists of lead, mercury, 1,1-dichloroethylene, phenol, polychlorinated biphenyls, and trichloroethylene in surface water. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contaminated surface water and groundwater.

24635 (PB–90-144064/XAB) **Health assessment for Hunterstown Road, Gettysburg, Pennsylvania, Region 3. CERCLIS No. PAD009862939. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 5 Mar 1986. 10p. Available from NTIS, PC A02/MF A01.

Hunterstown Road, a State Lead National Priority List site, is located near Gettysburg, Pennsylvania. A Responsible Party cleanup in 1984 removed drums and sludges from the lagoon area. In January 1985, the Environmental Protection Agency installed a fence around the excavation area to prevent access. Although the data provided are few and of poor quality, this limited information (lead less than 8,000 ppm and copper less than 2,000 ppm) does not indicate any evidence that the site presents an imminent and significant threat to public health. There is evidence that surface water, in the vicinity of surface and subsurface drums located at some distance from the site, is contaminated with volatile organic chemicals (trichloroethane, 1,1-dichloroethane, and trans-1,2-dichloroethene) at significant concentrations (greater than 1 ppm). However, this contamination does not appear to be coming from the fenced area of the site.

24636 (PB–90-144072/XAB) **Health assessment for Industrial Lane National Priorities List (NPL) Site, Northampton County, Pennsylvania, Region 3. CERCLIS No. PAD980508493. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 25 Oct 1988. 8p. Available from NTIS, PC A02/MF A01.

The Industrial Lane National Priorities List site is located in Northampton County, Pennsylvania. In 1980, low level groundwater contamination was detected in the Industrial Lane study area. To date the source of the contamination has not been conclusively identified. The contaminants of concern are tetrachloroethane, vinyl chloride, benzene, trichlorethene, and 1,1-dichloroethene. Most of these contaminants were also detected in residential wells. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances in the groundwater. Consideration should be given to adopting institutional controls to prevent future installation and use of potable water supply wells in the contaminated portion of the aquifer.

24637 (PB–90-144080/XAB) **Health assessment for Keystone Hydraulics/J. W. Rex Company, Lansdale, Pennsylvania, Region 3. CERCLIS No. PAD980926976. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 4 May 1988. 8p. Available from NTIS, PC A02/MF A01.

The Keystone Hydraulics/J. W. Rex Company Site has been listed on the National Priorities List. A metal heat-treating facility operated there from the 1940s until 1950. The Allied Paint Company then conducted operations until 1979. The site has been a construction equipment storage area since 1979. Identified contaminants of concern on-site include trichloroethylene (TCE), perchloroethylene (PCE), 1,1-dichloroethylene (1,1-DCE), cis-1,2-dichloroethylene (DCE), and vinyl chloride in well water. Identified soil contaminants include DCE, TCE, PCE, and vinyl chloride. Off-site contamination of groundwater by TCE and vinyl chloride has been found. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via groundwater and soil.

24638 (PB–90-144098/XAB) **Health assessment for Kimberton Site, Kimberton, Pennsylvania, Region 3. CERCLIS No. PAD980691703. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 9p. Available from NTIS, PC A02/MF A01.

The Kimberton Site (KS) is located in Kimberton (Chester County), Pennsylvania. KS consists of unlined lagoons that were used for the disposal of trichloroethylene (TCE) and related process waste. Removal actions have consisted of excavation and removal of contaminated soil to an off-site area. In addition, 57 drums were removed. Preliminary on-site groundwater sampling results have identified various volatile organic compounds. They include: TCE, 1,2-dichloroethylene, dichloroethylene (DCE), vinyl chloride, and tetrachloroethylene. In addition, sediment, soil, and sludge samples on-site identified TCE, DCE, lead, and chromium. Preliminary off-site groundwater sampling results identified DCE and TCE. In addition, polynuclear aromatic hydrocarbons (PAHs) were identified in sediment off-site. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances via direct contact with contaminated soil and sludge from on-site lagoons by on-site employees and by persons who have unauthorized access to the site. In addition, direct contact with and ingestion of contaminated groundwater by area residents are other exposure pathways of potential health concern. Other possible pathways of exposure include ingestion of bioaccumulated contaminants in the food chain and inhalation of site-related contaminants by on-site workers and/or area residents.

24639 (PB–90-144114/XAB) **Health assessment for Keystone Sanitation Landfill, Union Township, Adams County, Pennsylvania, Region 3. CERCLIS No. PAD054142781. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 11 Oct 1988. 8p. Available from NTIS, PC A02/MF A01.

The Keystone Sanitation Landfill site is a former farm which began receiving municipal waste and industrial construction debris in September 1966. The still active site is situated on a ridge, and runoff leaves the site from all directions. The environmental contamination on-site consists of 1,1,1-trichloroethane, trichloroethylene, vinyl chloride, benzene, 1,1-dichloroethane, 1,1-dichloroethylene, tetrachloroethylene, trans-1,2-dichloroethylene, chromium, lead, and N-nitrosodiphenylamine in groundwater. The environmental contamination off-site consists of tetrachloroethylene, 1,1,1-trichloroethane, 1,1-dichloroethylene, 1,1-dichloroethane, trichloroethylene in surface water; and lead, vinyl chloride, and 1,2-dichloroethylene in private wells. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via groundwater, soil, and surface water.

24640 (PB–90-144130/XAB) **Health assessment for Property Disposal (Office) Area (PDOA) and Southeast Industrial Area (NPL) (National Priorities List) Site, Letterkenny Army Depot, Chambersburg, Franklin County, Pennsylvania, Region 3. CERCLIS No. PA2210090054. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 30 Sep 1988. 21p. Available from NTIS, PC A03/MF A01.

The 19,520-acre Letterkenny Army Depot is in Franklin County, Pennsylvania. Past waste disposal practices have resulted in the contamination of soil, groundwater, and surface water on-site. Thirty-nine residential potable water supply wells to the northeast, east, and southeast of Letterkenny Army Depot were contaminated as a result. Continued migration of contaminated groundwater could result in the future contamination of additional private wells. Surface soils are contaminated with volatile organic chemicals (VOCs) but do not pose a significant health risk for on-base personnel unless remedial activities result in increased levels of exposure. These sites are of potential public health concern because of the risk to human health that could result from possible exposure to hazardous substances at concentrations that may result in adverse health effects. Human exposure to VOCs may have occurred via inhalation, ingestion, and direct dermal contact with groundwater.

24641 (PB–90-144155/XAB) **Health assessment for Palmerton Zinc, Palmerton, Pennsylvania, Region 3. CERCLIS No. PAD002395887. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 4 Feb 1987. 6p. Available from NTIS, PC A02/MF A01.

An active zinc smelter that began operation in 1898 has contaminated several square miles of eastern Pennsylvania with phytotoxic concentrations of zinc. Runoff containing soil contaminated with high concentrations of cadmium, lead, and zinc from the defoliated area contributes to heavy metal contamination identified in fish in area streams. Consumption of fish from the area streams presents a potential health threat; the public should be advised to consume fish from the immediate area streams on a limited basis only (no more than once per week). The proposed revegetation action will be an acceptable approach to eliminate a significant source of continuing contamination to the area's streams.

24642 (PB–90-144163/XAB) **Health assessment for Paoli Rail Yards, Paoli, Pennsylvania, Region 3. CERCLIS No. PAD980692594. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). Nov 1987. 33p. Available from NTIS, PC A03/MF A01.

An epidemiologic investigation of possible exposure to polychlorinated biphenyls (PCBs) was conducted following the discovery of widespread soil PCB contamination in Paoli, Pennsylvania. Concentration of PCBs in yard and street soil ranged from less than 1 ppm to more than 6,400 ppm. From several neighborhoods adjacent to the source of contamination, 66 persons were selected to represent the entire population of the neighborhoods (396 persons). The geometric mean and distribution of serum PCB concentrations in this group did not differ from the means and distribution of a large sample of persons selected from across the United States having no known environmental exposure. Thus, the population near the site in Paoli did not show exposure different from other U.S. populations having no known unusual source of exposure.

24643 (PB–90-144171/XAB) **Health assessment for Southern Maryland Wood Treating (SMWT) National Priorities List (NPL) Site, Hollywood, St. Mary's County, Maryland, Region 3. CERCLIS No. MDD980704852. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 17p. Available from NTIS, PC A03/MF A01.

The Southern Maryland Wood Treating National Priorities List site is located in Hollywood, St. Mary's County, Maryland. Approximately 12,000 gallons of dioxin-contaminated wastes and 2,000 gallons of wastes contaminated with volatile organic compounds or polynuclear aromatic hydrocarbons, or both, remain in on-site tanks used during wood treatment operations. Until remediation of the site is completed there is a potential public health concern from dermal absorption, ingestion, or inhalation of contaminants from groundwater, surface water, sediments, soil, and contaminated on-site structures.

24644 (PB–90-144189/XAB) **Health assessment for Woodlawn Landfill, Woodlawn, Maryland, Region 3. CERCLIS No. MDD980504344. Preliminary report.** Agency for Toxic Substances

and Disease Registry, Atlanta, GA (USA). 4 May 1988. 7p. Available from NTIS, PC A02/MF A01.

The Woodlawn Landfill (WL) is a 37-acre site located in Woodlawn (Cecil County), Maryland, and is a former municipal landfill (1965 to 1978). Contaminants of health concern include vinyl chloride, toluene, and benzene. These contaminants are present in both on-site and off-site groundwater. The site is considered to be of potential public health concern to area residents because of the risk to human health caused by off-site migration of contaminated groundwater and the possibility of human exposure to hazardous substances in nearby wells.

24645 (PB–90-144205/XAB) **Health assessment for Ambler Asbestos Piles National Priorities List (NPL) Site, Ambler, Pennsylvania, Region 3. CERCLIS No. PAD000436436. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 31 Oct 1988. 19p. Available from NTIS, PC A03/MF A01.

The Ambler Asbestos Piles National Priorities List site is located in the Borough of Ambler, Pennsylvania. Waste generated from the manufacture of asbestos products was disposed on-site and at two off-site piles. Asbestos is the primary contaminant of concern and was detected in air, soil, groundwater, surface water, and sediment. The most significant potential health threat posed by the site is the release of asbestos fibers to the ambient air. The site is of potential public health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse human health effects. Human exposure to asbestos may be occurring via inhalation and ingestion.

24646 (PB–90-144213/XAB) **Health assessment for American Electronics Lab, Montgomery, Pennsylvania, Region 3. CERCLIS No. PAD980692693. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 4 May 1988. 7p. Available from NTIS, PC A02/MF A01.

The American Electronics Lab is a 20-acre site located in Montgomeryville (Montgomery County), Pennsylvania. The active site currently produces communications equipment. Drums containing trichloroethylene (TCE) leaked their contents onto the soil. Contamination of groundwater with 1,1,1-trichloroethane (TCA) and trichloroethylene (and its respective degradation products) was discovered in 1979. On-site soils are contaminated with TCE at concentrations of 50 ppm. TCE is the main contaminant of concern and has been detected in on-site soil and groundwater. Other contaminants detected on-site included TCA, cis-1,2-dichloroethylene, 1,1-dichloroethylene, and 1,1-dichloroethane. Site related contaminants have been detected in off-site wells at lower levels. The site is considered to be of potential public health concern to on-site workers and possibly to area residents using private wells located downgradient from the site because of the risk to human health caused by the possibility of human exposure to hazardous substances.

24647 (PB–90-144221/XAB) **Health assessment for Ametek, Inc. (Zone 2) North Penn Area, Hatfield, Pennsylvania, Region 3. CERCLIS No. PAD002342475. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 29 Jun 1988. 7p. Available from NTIS, PC A02/MF A01.

The Ametak, Inc. site, located in Hatfield, Pennsylvania, was used for the precision manufacture of ball bearings. Waste lagoons on the site were emptied in 1983, backfilled, and revegetated. On-site groundwater is contaminated with trichloroethene, 1,1-dichloroethene, and 1,1,1-trichloroethane. Off-site groundwater is contaminated with the same chemicals at lower levels. Limited soil sampling found 1,1-dichloroethene, trichloroethene, and perchloroethene on-site. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via groundwater. The extensive contamination of the groundwater beneath the site and its subsequent movement off-site is cause for concern that the contaminants will move into private wells. Contaminated on-site soils will continue to provide a source of contamination to the groundwater.

24648 (PB–90-144239/XAB) **Health assessment for Avco Lycoming (Williamsport Division) Site, Williamsport, Pennsylvania, Region 3. CERCLIS No. PAD003053709. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 30 Sep 1988. 7p. Available from NTIS, PC A02/MF A01.

The Avco Lycoming (Williamsport Division) site is an aircraft engine production facility on a 28-acre site in urban Williamsport, Pennsylvania. The plant includes a still for the reclamation of petroleum solvents and, since 1950, a waste treatment facility. Environmental sampling indicates that the contaminants of concern are volatile organic compounds present in groundwater, including trichloroethylene, 1,2-trans-dichloroethylene, vinyl chloride, 1,1-dichloroethylene and chloroform. Chromium was also found in an on-site recovery well. The site is considered to be of public health concern because of the risk to human health caused by the likelihood of past exposure and the possibility of future exposure to hazardous substances via contaminated groundwater.

24649 (PB–90-144247/XAB) **Health assessment for Bally Groundwater, Bally, Berk County, Pennsylvania, Region 3. CERCLIS No. PAD061105128. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 2 Dec 1988. 8p. Available from NTIS, PC A02/MF A01.

The Bally Groundwater Company site consists of the Borough of Bally municipal well number three. On December 2, 1982, the Pennsylvania Department of Environmental Resources discovered organic solvent contamination in the well; the well was taken out of service shortly thereafter. The environmental contamination consists of 1,1-dichloroethylene, 1,1,1-trichloroethane, trichloroethylene, 1,1-dichloroethane, and trans-1,2-dichloroethylene. The environmental contamination off-site consists of 1,1-dichloroethylene, 1,1-dichloroethane, chloroform, 1,2-dichloroethane, 1,1,1-trichloroethane, trichloroethylene, and carbon tetrachloride in groundwater. The site is considered to be of public health concern because of the risk to human health caused by the likelihood of exposure to hazardous substances via ingestion, dermal contact and absorption, and inhalation (volatile components) of contaminated groundwater.

24650 (PB–90-144254/XAB) **Health assessment for Bendix Flight Systems National Priorities List (NPL) Site, Bridgewater Township, Susquehanna County, Pennsylvania, Region 3. CERCLIS No. PAD003047974. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 16 Dec 1988. 19p. Available from NTIS, PC A03/MF A01.

The Bendix Flight Systems National Priorities List site is an active manufacturing facility located in the Bridgewater Township, Susquehanna County, Pennsylvania. Past waste disposal practices at the facility have resulted in the contamination of soil, surface water, and groundwater with volatile organic chemicals (VOCs). The groundwater VOC contamination has migrated into residential wells and the Bendix Flight System Division potable water supply wells. Activated carbon treatment systems have been provided to the affected residences, and the units are being maintained by Bendix Flight Systems Division. The site is of potential public health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse human health effects. Human exposure to VOCs may be occurring and may have occurred in the past via inhalation, ingestion and direct dermal contact.

24651 (PB–90-144262/XAB) **Health assessment for Croydon Tce, Croydon, Pennsylvania, Region 3. CERCLIS No. PAD981035009. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

The Croydon TCE site is located between the Townships of Croydon and Bristol (Bucks County), Pennsylvania. Volatile organic compounds (VOCs) have been detected in area groundwater and surface waters. The source of contamination has not been established. Preliminary on-site groundwater sampling results have identified various VOCs such as trichloroethylene (TCE) and 1,1,1-trichloroethane. Preliminary off-site sampling results identified TCE in groundwater and surface water. In addition TCE and nitrates were detected in 8 residential wells and lead was detected in off-site groundwater. Polychlorinated biphenyls were detected in

off-site soil. The site is considered to be of public health concern because of the risk to human health caused by the likelihood of human exposure to hazardous substances. Area residents may be exposed through direct contact with and ingestion of contaminated groundwater. Moreover, area residents may be exposed through inhalation of contaminated groundwater during household uses. Direct contact with and possible ingestion and inhalation of contaminated soil off-site (e.g., school yard) and ingestion of fish that bioaccumulate site-related contaminants are other possible exposure pathways.

24652 (PB–90-144270/XAB) **Health assessment for Cryochem, Inc., Worman, Berks County, Pennsylvania, Region 3. CERCLIS No. PAD002360444. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 2 Dec 1988. 8p. Available from NTIS, PC A02/MF A01.

The Cryochem, Inc. approximately 19-acre site is a metal fabrication company that has been in operation since 1962. Prior to 1962, an organic solvent was used to remove a dye that was applied to welded connections to check for weld integrity. Excess solvent was placed in the shop drain system which discharged into nearby surface waters. The environmental contamination on-site consists of 1,1-dichloroethylene, 1,1-dichloroethane, 1,1,1-trichloroethane, trichloroethylene, and tetrachloroethylene in groundwater; 1,1-dichloroethylene, 1,1-dichloroethane, and 1,1,1-trichloroethane in surface water; and 1,1,1-trichloroethane in sediment. Contamination off-site consists of 1,1-dichloroethylene and 1,1-dichloroethane in surface water; and 1,1,1-trichloroethane, trichloroethylene, and tetrachloroethylene in residential well water. The site is considered to be of public health concern because of the risk to human health caused by the likelihood of exposure to hazardous substances via contaminated groundwater.

24653 (PB–90-144288/XAB) **Health assessment for Delta Quarries/Stotler Landfill, Antis/Logan Township, Blair County, Pennsylvania, Region 3. CERCLIS No. PAD981038052. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 15 Nov 1988. 7p. Available from NTIS, PC A02/MF A01.

The Delta Quarries (Stotler Landfill) site is an inactive, unpermitted municipal waste facility which operated from the 1960s until 1985. The environmental contamination on-site consists of trans-1,2-dichloroethylene, trichloroethylene, and 1,1-dichloroethane in groundwater. In addition, lead was detected in groundwater during one sampling event. The environmental contamination off-site consists of trichloroethylene, tetrachloroethylene, and 1,1,1-trichloroethane in surface water; and tetrachloroethylene in groundwater. The off-site groundwater contamination was found in a residential well and in a spring. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contaminated groundwater and surface water.

24654 (PB–90-144296/XAB) **Health assessment for Dorney Road Landfill National Priorities List (NPL) Site, Lehigh County, Pennsylvania, Region 3. CERCLIS No. PAD980508832. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 21 Nov 1988. 17p. Available from NTIS, PC A03/MF A01.

Municipal and industrial wastes were disposed in the Dorney Road Landfill National Priorities List Site from 1952 through 1978. The landfill is located in Lehigh County, Pennsylvania. Heavy metals and volatile organic compounds (VOCs) have leached from the waste material and migrated into the local groundwater aquifer which is used as a potable water supply. Contaminants of concern are dieldrin, manganese, chlorobenzene, chromium, methyl-ethyl ketone, barium, arsenic, 1,2-dichloroethene, trichloroethene, tetrachloroethene, vinyl chloride, benzene, manganese, barium, and lead. Human exposure to VOCs and metals may be occurring via ingestion, inhalation, and direct dermal contact with contaminants in groundwater and soil. No health study follow-up is indicated at this time.

24655 (PB–90-144304/XAB) **Health assessment for Douglassville Disposal Site, Douglassville, Berks County, Union Township, Pennsylvania, Region 3. CERCLIS No. PAD002384865. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 17 Apr 1989. 13p. Available from NTIS, PC A03/MF A01.

The Douglassville Disposal site is on the National Priorities List. Between the years 1941 and 1986, a waste oil recycling (1941-1986) and waste oil refining (1979-1986) operation was conducted on the site. Contamination on-site consists of lead, arsenic, barium, cadmium, chromium, benzene, toluene, xylenes, antimony, cobalt, manganese, nickel, 1,1-dichloroethane, 1-2-dichloroethane, tetrachloroethene, trichloroethene, vinyl chloride, trans-1,2-dichloroethene, non-carcinogenic polycyclic aromatic hydrocarbons (PAHs), carcinogenic PAHs, and polychlorinated biphenyls (PCBs). Contamination off-site consists of lead in water from several domestic drinking water wells, copper, and nickel. The site is of public health concern because of the risk to human health resulting from probable exposure to hazardous substances at concentrations that may result in adverse human health effects and the physical hazards associated with the site. Human exposure to lead, PCBs, PAHs, and other site contaminants may occur by contact with on-site soils and sediments, by ingestion of contaminated groundwater, or by the consumption of contaminated biota.

24656 (PB–90-144320/XAB) **Health assessment for East Mount Zion National Priorities List (NPL) Site, Springettsbury Township, York County, Pennsylvania, Region 3. CERCLIS No. PAD980690549. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 31 Jan 1989. 9p. Available from NTIS, PC A02/MF A01.

The East Mount Zion Site, formerly Fetrow's Landfill, is an inactive, 10-acre landfill which received municipal and industrial waste from 1938 until 1972. Trace concentrations of organic compounds and a relatively high concentration of an inorganic contaminant (ammonia) were detected in samples collected from the site in 1983. Benzene, dichlorobenzenes, and ammonia were reported in leachate samples. In groundwater, trichloroethene, vinyl chloride, benzene, ammonia and lead were detected. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via ingestion of contaminated groundwater. Because of the uncertainty of the extent of contamination at the site, other exposures may also be occurring.

24657 (PB–90-144338/XAB) **Health assessment for Eastern Diversified Metals, Rushtownship, Pennsylvania, Region 3. CERCLIS No. PAD980830533. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 1 Sep 1988. 8p. Available from NTIS, PC A02/MF A01.

The Eastern Diversified Metals (EDM) Site is listed on the National Priorities List. The 25-acre former wire recycling site is located in Rush Township (Schuylkill County), Pennsylvania. A pile of waste fluff approximately 90 million cubic feet (157 million pounds) exists on-site. In addition an unknown quantity of sludge from an on-site sewage treatment facility was deposited on top of the fluff pile. Preliminary on-site sediment sampling results have identified polychlorinated biphenyls (PCBs) (Aroclor 1016, Aroclor 1260), bis(2-ethylhexyl)phthlate, and hexachlorobenzene. Lead, barium, phenols, and benzene were identified in on-site leachate samples. In addition, mercury was identified in on-site groundwater. Preliminary off-site sediment sampling results identified 1,1,1-trichloroethane, benzene, PCBs (Aroclor 1260 and Aroclor 1016), and DEHP. The site is considered to be of public health concern because of the risk to human health caused by the likelihood of human exposure to hazardous substances. Exposure to contaminated groundwater, surface water, soils and sediment through direct contact and ingestion is possible.

24658 (PB–90-144346/XAB) **Health assessment for Fischer and Porter National Priorities List (NPL) Site, Warminster, Bucks County, Pennsylvania, Region 3. CERCLIS No. PAD002345817. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 18 Apr 1989. 11p. Available from NTIS, PC A03/MF A01.

The Fischer and Porter (F&P) National Priorities List Site is located in Warminster, Buck County, Pennsylvania. The F&P facility has been operating on the Warminster property since 1947. Flow

meters are manufactured at the facility. No soil, air, or surface water monitoring has been conducted at the site or off-site even though spills and dumping are suspected as possible causes for the groundwater contamination. In 1979 and 1980, levels as high as 87,000 ppb trichloroethylene (TCE) and 26,000 ppb tetrachloroethylene (TCE) were detected in on-site groundwater. The site is of potential public health concern because of the risk to human health caused by human exposure to hazardous substances at levels that may result in adverse health effects. Human exposure to TCE and PCE may be currently occurring and may have occurred in the past via ingestion of, inhalation of, and dermal contact with contaminated groundwater. Exposure to TCE and PCE may be occurring through ingestion of, inhalation of, and dermal contact with contaminated surface water and soils; inhalation of contaminated air; and ingestion of contaminated biota. The lack of monitoring data for these media does not allow for a complete public health implication evaluation at this time.

24659 (PB–90-144353/XAB) **Health assessment for Gentle Cleaners, Inc./Granite Knitting Mill, Inc., Souderton, Pennsylvania, Region 3. CERCLIS No. PAD096834494. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 29 Jun 1988. 8p. Available from NTIS, PC A02/MF A01.

The Gentle Cleans, Inc./Granite Knitting Mills, Inc. site is on the National Priorities List. Both facilities are still in operation. A plume of contaminated groundwater has been identified within the general vicinity of the site. The contaminants of concern are those volatile organic compounds typically used in the dry cleaning industries: tetrachloroethylene, 1,1-dichloroethylene, trichloroethylene, 1,2-dichloroethylene, carbon tetrachloride, and chloroform. A municipal well and a domestic well near the site were contaminated with perchloroethylene. The site is considered to be of public health concern because of the risk to human health caused by the likelihood of exposure to hazardous substances via volatile organic compounds in groundwater.

24660 (PB–90-144361/XAB) **Health assessment for Pigeon Point Landfill Site (New Castle City Landfill), New Castle, Delaware, Region 3. CERCLIS No. DED980494603. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 11 May 1988. 7p. Available from NTIS, PC A02/MF A01.

The Pigeon Point Landfill 180-acre site includes a former municipal landfill that reportedly received industrial wastes during the period from 1968 to 1985. Initial sampling of groundwater and leachate revealed inorganic and organic chemicals at levels of health concern; however, per anecdotal information received from EPA, subsequent sampling has not confirmed initial sampling results. Only the original sampling data were available for this health assessment and since the data are questionable, they are not reported here. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via groundwater and leachate. However, information available on the site at present is of questionable validity. Additional information on contaminants released, populations potentially exposed, and environmental pathways through which the contaminants can reach these populations is needed.

24661 (PB–90-144379/XAB) **Health assessment for Standard Chlorine of Delaware, Delaware City, Delaware, Region 3. CERCLIS No. DED041212473. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 1990. 7p. Available from NTIS, PC A02/MF A01.

The Standard Chlorine of Delaware Site (SCD) is located in Delaware City (New Castle County), Delaware. Two spills occurred at the site in 1981 and 1986 and impacted area groundwater. Preliminary groundwater sampling results from on-site monitoring wells have identified benzene, monochlorobenzene, orthodichlorobenzene, paradichlorobenzene, and 1,2,4-trichlorobenzene. No further sampling information was provided. The site is of potential public health concern because of the risk to human health resulting from possible exposure to hazardous substances at a concentration that may result in adverse health effects. SCD poses a potential public health threat to on-site employees and/or remedial workers through direct contact of soil. In addition, area residents that use area surface waters for swimming and fishing may be at increased risk of possible adverse health risks through direct contact and ingestion of fish that bioaccumulate site related contaminants.

24662 (PB–90-144387/XAB) **Health assessment for Tybouts Corner Land (Tybouts) National Priorities List (NPL) Site, Wilmington, New Castle County, Delaware, Region 3. CERCLIS No. DED000606079. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 7 Feb 1989. 15p. Available from NTIS, PC A03/MF A01.

The Tybouts Corner Landfill (Tybouts) National Priorities List site is located in New Castle County, Delaware. The site was originally a sand and gravel pit and was used as a municipal sanitary landfill from December 1968 to July 1971. Industrial wastes were also disposed of there. The site is of potential public health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects. Human exposure to VOCs via inhalation of potentially contaminated off-site soil and air and ingestion of and dermal contact with potentially contaminated off-site soil may possibly occur. Human exposure to VOCs via ingestion of, inhalation of, and dermal contact with groundwater, surface water, air and soil may have occurred in the past. Contaminants of concern are: benzene, chloroethane, chloromethane, dichlorodifluoroethane, 1,1-dichloroethane, 1,2-dichloroethane, 1,2-trans-dichloroethylene, 1,2-dichloropropane, fluorotrichloromethane, 2-hexanone, 4-methyl 2-pentanone, styrene, tetrachloroethylene, toluene, trichloroethylene, vinyl chloride, xylenes, 2-butanone, and methylene chloride.

24663 (PB–90-144395/XAB) **Health assessment for Tyler Refrigeration Pit, Smyrna, Delaware, Region 3. CERCLIS No. DED980705545. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 15 Nov 1988. 7p. Available from NTIS, PC A02/MF A01.

The Tyler Refrigeration Pit site from 1952 until 1969 was used to dispose of metal cleaning solvents and paint room wastes. On-site contamination consists of toluene (25 ppm), 1,1-dichloroethane (10 ppm), and 1,1,1-trichloroethane (15 ppm) in soil. Off-site contamination consists of trichloroethylene (70 ppb) in groundwater. The presence of trichloroethylene in the public water supply, exceeding the Safe Drinking Water Act's Maximum Contaminant Level of 5 ppb, is considered to be a public health threat. From the information available, ATSDR cannot comment on the public health implications of the Tyler Refrigeration Pit.

24664 (PB–90-144403/XAB) **Health assessment for York County Solid Waste Landfill, York County, Hopewell Township, Pennsylvania, Region 3. CERCLIS No. PAD980830715. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 26 Oct 1988. 7p. Available from NTIS, PC A02/MF A01.

The York County Waste Landfill site is an active unlined landfill which has been in operation since November 1974. Environmental contamination on-site consists of 1,2-dichloroethane (28 ppb), 1,1,1-trichloroethane (11 ppb), methylene chloride (12 ppb), trichlorofluoromethane (8 ppb), dichlorodifluoromethane (68 ppb), toluene (5 ppb), methyl ethyl ketone (140 ppb), acetone (170 ppb), and tetrachloroethylene (12 ppb) in groundwater. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contaminated groundwater.

24665 (PB–90-144411/XAB) **Health assessment for Atlantic Wood Industries, Inc., Portsmouth, Virginia, Region 3. CERCLIS No. VAD990710410. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 2 Dec 1988. 8p. Available from NTIS, PC A02/MF A01.

The Atlantic Wood Industries, Inc. 50-acre site is the location of a wood processing plant which used pentachlorophenol and creosote in its process. The environmental contamination on-site consists of naphthalene (46 ppm), phenol (3.1 ppm), phenanthrene (316 ppm), and pentachlorophenol (13 ppm) in groundwater; and pentachlorophenol (15,000 ppm), phenanthrene (56,000 ppm), naphthalene (1,450 ppm), and phenol (5.1 ppm) in soil. The site is considered to be of potential public health concern because of the

risk to human health caused by the possibility of exposure to hazardous substances via surface water, soil, sediment, and air.

24666 (PB–90-144437/XAB) **Health assessment for C and R Battery Company, Inc., Chesterfield, Chesterfield County, Virginia, Region 3. CERCLIS No. VAD049957913. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 19 Jul 1988. 8p. Available from NTIS, PC A02/MF A01.

The C&R Battery site was the location of an automobile battery reclamation operation from 1970 until 1985. Inorganic materials quantified in on-site surface soils included lead (67,700 ppm), cadmium (99 ppm), and arsenic (103 ppm). Lead was also measured in groundwater (2.2 ppm) on-site, and surface water (0.5 ppm) off-site. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via groundwater.

24667 (PB–90-144445/XAB) **Health assessment for Chisman Creek, York County, Virginia, Region 3. CERCLIS No. VAD980712913. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 2 Apr 1987. 34p. Available from NTIS, PC A03/MF A01.

Groundwater on the 36-acre Chisman Creek site is contaminated with high levels of vanadium, molybdenum, nickel, and sulfate at levels which may pose a significant or potential public health threat. The authors are concerned about the potential for local wells, which are still being used for drinking and other purposes, to become contaminated. A complete health assessment of the health threat posed by contaminants in existing residential wells and in surface soils on the site was not possible because the data for these items was either incomplete or unavailable.

24668 (PB–90-144452/XAB) **Health assessment for Culpeper Wood Preservers, Culpeper, Virginia, Region 3. CERCLIS No. VAD059165282. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 15 Mar 1989. 6p. Available from NTIS, PC A02/MF A01.

The Culpeper Wood Preservers Site is proposed for inclusion on the National Priorities List. The site is an active wood preserving operation located in Culpeper (Culpeper County), Virginia. Preliminary on-site groundwater and sediment sampling results have identified arsenic (6 ppm, 660 ppb) and hexavalent chromium (30 ppm, 45 ppb). No further site contaminants were reported. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances.

24669 (PB–90-144460/XAB) **Health assessment for Defense General Supply Center, Richmond, Chesterfield County, Virginia, Region 3. CERCLIS No. VA3971520751. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 2 Dec 1988. 9p. Available from NTIS, PC A02/MF A01.

The Defense General Supply Center site is part of the Department of Defense. The site is used for storage of bulk drummed chemicals, recovery of chemicals, reclamation of drums and vehicle maintenance activities. It also contains a landfill which received construction debris and damaged containers of chemicals. The environmental contamination on-site includes trichloroethylene, perchloroethylene, fluoranthene, naphthalene, benzo(a)pyrene, chlordane, anthracene, 1,4-dichlorobenzene, dibenzofuran, iron, manganese, barium, lead, arsenic, and chromium in soil and water. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contaminated groundwater and possibly contaminated fish.

24670 (PB–90-144486/XAB) **Health assessment for First Piedmont Corporation, Beaver Park, Virginia, Region 3. CERCLIS No. VAD980554984. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 26 Nov 1985. 8p. Available from NTIS, PC A02/MF A01.

A former quarry in Beaver Park, Virginia used for waste disposal accepted approximately 15,000 gallons of liquid waste, creating a potential source for groundwater contamination. Sampling results from nearby private wells show minimal contamination; however, values for benzene and xylenes were reported as unacceptable. These wells must be resampled to permit evaluation of potential health threat. Neither surface water nor soil samples show health significant levels of contamination.

24671 (PB–90-144494/XAB) **Health assessment for Greenwood Chemical Company, Newtown, Virginia, Region 3. CERCLIS No. VAD003125374. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 2 May 1988. 8p. Available from NTIS, PC A02/MF A01.

The Greenwood Chemical Company site in Newtown, Virginia manufactured specialty chemicals for industrial, pesticide, and pharmaceutical operations for forty years. On-site lagoon sludge is contaminated with toluene (2.8-39,000 ppm), naphthalene (7.8-12,000 ppm), perchloroethylene (ND-2.1 ppm), benzene (ND-0.52 ppm), and cyanide (13-470 ppm). Groundwater on-site is contaminated with toluene (ND-0.15 ppm), chloroform (ND-0.26 ppm), and benzene (ND-0.52 ppm). The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances. This is especially a concern while open lagoons and raw chemical wastes are present.

24672 (PB–90-144502/XAB) **Health assessment for H and H Incorporated Burn Site, Farrington, Virginia, Region 3. CERCLIS No. VAD980539878. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 5 May 1988. 7p. Available from NTIS, PC A02/MF A01.

The H&H Incorporated Burn Site, located in Hanover County, Virginia, contains a pit where dry printing ink residues were disposed of. Groundwater contaminants of concern (and maximum concentrations) include benzene (25 ppb), toluene (1180 ppb), chromium (110 ppb), barium (1,300 ppb), beryllium (20 ppb). Organics, including phthalates (131,000 ppb), vinyl chloride (3,600 ppb), toluene (82 ppb), and xylenes (45 ppb), were detected in leachate and/or runoff, presumably emanating from the pit area. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances.

24673 (PB–90-144510/XAB) **Health assessment for IBM Manassas, Manassas, Virginia, Region 3. CERCLIS No. VAD064872575. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 15 Mar 1989. 7p. Available from NTIS, PC A02/MF A01.

The IBM Manassas Site (IBM) is on the National Priorities List. IBM was involved in the purification, storing, using, and recycling of chlorinated organic solvents. Preliminary on-site sampling results have identified various volatile organic compounds (VOCs). They include: tetrachloroethylene (PCE), (2 to 209,200 ppb in groundwater, ND to 7,974 ppb in soil), chlorobenzene (ND to 60 ppb in groundwater, ND to 56 ppb in soil), trichloroethylene (TCE), (ND to 2,500 ppb in groundwater, ND to 1,077 ppb in soil), trans-dichloroethylene (ND to 2,500 ppb in groundwater), chloroform (ND to 14 ppb in groundwater, ND to 21 ppb in soil), methylene chloride (ND to 42 ppb in groundwater, ND to 21 ppb in soil), 1,1-dichloroethane (ND to 31 ppb in groundwater), vinyl chloride (ND to 24 ppb in groundwater), and acetone (ND in groundwater, ND to 627 ppb in soil). The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances. Because information on the current status of the site was not reported, human exposure may occur via ingestion and direct contact with contaminated groundwater.

24674 (PB–90-144528/XAB) **Health assessment for L. A. Clarke and Sons Wood Treatment Facility, Fredricksburg, Virginia, Region 3. CERCLIS No. VAD007972482. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). Mar 1988. 15p. Available from NTIS, PC A03/MF A01.

The L.A. Clarke and Sons Wood Treatment (L.A. Clarke) National Priorities List Site is located in Spotsylvania County, Virginia, southeast of Fredericksburg. The site is a wood treatment facility where soil, sediment, surface runoff and groundwater are contaminated with creosote, the primary constituent of which is polynuclear aromatic hydrocarbons (PAHs), and, in isolated samples, metals. A

potential public health threat exists at the site as a result of potential inhalation, ingestion, and dermal exposure to constituents of creosote and arsenic in contaminated soil, sediment, surface runoff, and food.

24675 (PB–90-144536/XAB) **Health assessment for Love's Container Landfill, Buckingham, Virginia, Region 3. CERCLIS No. VAD089027973. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 5 Dec 1985. 9p. Available from NTIS, PC A02/MF A01.

Love's Container Service Landfill covers eight acres in a rural area near the town of Buckingham, Virginia. Sampling indicated that on-site groundwater and off-site residential well water are contaminated by chromium and beryllium. There does not appear to be any indication of contamination in the surface soil, the surface water, nor the private wells. The monitoring wells indicate only trace levels of contamination. The site does not appear to present any threat to human health.

24676 (PB–90-144551/XAB) **Health assessment for Westline National Priorities List (NPL) Site, Westline, McKean County, Pennsylvania, Region 3. CERCLIS No. PAD980692537. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 7 Feb 1989. 15p. Available from NTIS, PC A03/MF A01.

The Westline National Priorities site is located in the rural town of Westline, McKean County, Pennsylvania. Westline has a permanent population of about 100 and covers an area of about 40 acres. During the first half of the century, a chemical plant released or disposed of a tar-like waste substance that has accumulated at numerous locations in the town. Contaminants associated with the waste tar and/or with other releases from the plant have been detected principally in surface soils and groundwater. The site is of potential health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects. Contaminants, principally nonvolatile organic compounds, have been detected in soils in the town area at levels for which exposure through ingestion, dermal contact, and possibly inhalation pose a potential health concern. Groundwater, although found to be substantially contaminated with organic compounds at one monitoring location and with lead and chromium at a domestic well, does not pose a current health concern because domestic wells in the town are no longer used for any purpose. More information is needed to evaluate other issues of potential concern.

24677 (PB–90-144569/XAB) **Health assessment for Whitmoyer Laboratories, Jackson Township, Lebanon County, Pennsylvania, Region 3. CERCLIS No. PAD003005014. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 17 Nov 1988. 8p. Available from NTIS, PC A02/MF A01.

The Whitmoyer Laboratories 17.5-acre site is formerly an animal arsenical pharmaceutical manufacturing facility that operated from 1934 to 1984. In the early 1960s, approximately four million pounds of soluble arsenic wastes were placed into unlined lagoons. The environmental contamination on-site consists of arsenic and aniline in solid material in the concrete vault; arsenic, anile, 1,1-trichloroethane, and trans-1,2-dichloroethene in groundwater; arsenic in soil; and arsenic in surface water. Contamination off-site consists of arsenic, aniline, 1,1,1-trichloroethane in groundwater from an industrial well; arsenic in surface water; and arsenic in sediment. In addition, extensive sampling of domestic and industrial wells off-site has found arsenic, aniline, 1,2-dichloroethane, trans-1,2-dichloroethylene, trichloroethylene, 1,1,1-trichloroethane, and tetrachloroethylene. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contaminated groundwater, surface water, sediment, soil, and possibly air.

24678 (PB–90-144585/XAB) **Health assessment for Modern Sanitation Landfill, York, Pennsylvania, Region 3. CERCLIS No. PAD980539068. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 4 Jan 1989. 8p. Available from NTIS, PC A02/MF A01.

The 72-acre active Modern Sanitation Landfill (MSL) is located in York (York County), Pennsylvania. MSL reportedly received hazardous waste from 1976 to 1979. Preliminary on-site groundwater sampling results have identified methylene chloride, 1,1-dichloroethane, 1,2-trans-dichloroethylene, toluene, ethylbenzene, benzene, and vinyl chloride. Preliminary off-site surface water sampling results have identified methylene chloride, 1,1,1-trichloroethane, 1,1-dichloroethane, trichloroethylene (TCE), and cadmium. In addition, TCE was identified in off-site groundwater. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances. Direct contact with and ingestion of contaminated groundwater and surface water are the exposure pathways of concern. In addition, direct contact with contaminated sediment and soils, inhalation of volatilized contaminants, and ingestion of bioaccumulated contaminants in the fish may be other possible environmental pathways. Additional information on contaminants released, populations potentially exposed, and environmental pathways through which the contaminants can reach these populations is necessary.

24679 (PB–90-144593/XAB) **Health assessment for Moyer Landfill, Collegeville, Pennsylvania, Region 3. CERCLIS No. PAD980508766. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 17 Apr 1989. 19p. Available from NTIS, PC A03/MF A01.

The Moyer Landfill operated from the 1940s until 1981. The landfill accepted municipal solid and liquid wastes, sewage plant sludges, and industrial liquid and solid wastes. Monitoring programs detected principally metals (including metaloids, such as arsenic) and semi-volatile organic compounds in groundwater, surface soils, surface water, and sediments. Several contaminants also were detected in the tissue of game fish samples taken from the creek. The site is of public health concern because of the risk to human health resulting from probable exposure to hazardous substances at concentrations that may result in adverse health effects.

24680 (PB–90-144619/XAB) **Health assessment for MW Manufacturing Site, Danville, Montour County, Pennsylvania, Region 3. CERCLIS No. PAD980691372. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 2 Dec 1988. 7p. Available from NTIS, PC A02/MF A01.

The MW Manufacturing (Domino Salvage) site was used during the 1960s and 1970s for the mechanical and chemical recovery of copper from scrap wire. Five acres of the site consist of processed and unprocessed piles of wire and wire insulation. The environmental contamination on-site consists of lead, perchloroethylene, trichloroethylene, vinyl chloride, methylene chloride, and trans-1,2-dichloroethylene in groundwater; vinyl chloride and trichloroethylene in surface water; vinyl chloride in lagoon water; and trichloroethylene, 1,1,1-trichloroethane, and benzene in soil and sediment. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contaminated groundwater, surface water, soil/sediment, and airborne particulates and vapors.

24681 (PB–90-144627/XAB) **Health assessment for Naval Air Development Center, Warminster, Pennsylvania, Region 3. CERCLIS No. PA6170024545. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 17 Jan 1989. 9p. Available from NTIS, PC A02/MF A01.

The U.S. Naval Air Development Center (NADC) site is located in Warminster (Bucks County), Pennsylvania. Of the six landfills of concern, one is an active waste disposal consisting of industrial solids, sludges, and liquids, all generated on-site from various NADC activities. Preliminary on-site groundwater sampling results have identified various volatile organic compounds. They include trichloroethylene (TCE), tetrachloroethylene, 1,1,1-trichloroethane, 1,1-dichloroethane. In addition, chromium, cadmium, mercury, and lead were identified. Preliminary off-site groundwater sampling information identified TCE, tetrachloroethylene, and 1,1,1-trichloroethane. Neither on- or off-site soil sampling has been performed. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances. Direct contact, ingestion, and possible inhalation of contaminated soil by on-base

residents, especially children, is a major pathway of exposure. Other possible exposure pathways include ingestion of and direct contact with groundwater and ingestion of contaminants that bioaccumulate in the food chain.

24682 (PB–90-144635/XAB) **Health assessment for Novak Sanitary Landfill, South Whitehall, Pennsylvania, Region 3. CERCLIS No. PAD079160842. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 30 Jun 1988. 8p. Available from NTIS, PC A02/MF A01.

The Novak Sanitary Landfill Site was originally operated as a quarry. Demolition waste (e.g., scrap wood, brick, etc.) disposal may have began as early as the 1950s. The Pennsylvania Department of Environmental Resources allowed expansion of disposal activities to include municipal and industrial wastes. Identified contaminants of concern on the site include trichloroethylene, tetrachloroethene, vinyl chloride, benzene, lead, and barium in groundwater. Identified contaminants in leachate include methyl-ethyl ketone, methyl-isobutyl ketone, cadmium, chromium, arsenic, and barium. 1,1-Dichloroethene has been found in off-site wells and in a sedimentation pond. On-site soil contamination has been confirmed by sampling. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances.

24683 (PB–90-144643/XAB) **Health assessment for Old City of York Landfill, Seven Valleys, Pennsylvania, Region 3. CERCLIS No. PAD980692420. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 20 Jan 1989. 9p. Available from NTIS, PC A02/MF A01.

The Old City of York Landfill is a former landfill located in Seven Valleys (York County), Pennsylvania. It was reported that industrial waste was disposed of on-site. Preliminary on-site surface water sampling results have identified selenium, chromium, lead, carbon tetrachloride, trichloroethylene (TCE), and polynuclear aromatic hydrocarbons. TCE and tetrachloroethylene have been found in domestic wells. Off-site surface water sampling identified arsenic. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances. Potential human exposure to contaminants include ingestion of and direct contact with groundwater, surface water, soil, and possible ingestion of bioaccumulated contaminants in the food chain.

24684 (PB–90-144650/XAB) **Health assessment for Taylor Borough National Priorities List (NPL) Site, Taylor Borough, Lackawanna County, Pennsylvania, Region 3. CERCLIS No. PAD980693907. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 17 Apr 1989. 17p. Available from NTIS, PC A03/MF A01.

The Taylor Borough National Priorities List site is located in Taylor Borough, Lackawanna County, Pennsylvania, about three miles south of the City of Scranton. The site is an inactive municipal landfill. Sometime after closure, drummed industrial wastes were disposed at several locations on the landfill surface. It was later observed that wastes had escaped from drums at some locations onto the ground and into some pits. The drum disposal locations were investigated; and remediations, consisting of waste-drum and contaminant removals and clay caps, have been completed. The site is of potential health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects. Human exposure to contaminants at a small off-site pond adjacent to the landfill may be occurring via ingestion, inhalation, and dermal contact.

24685 (PB–90-144668/XAB) **Health assessment for the Transicoil, Inc. (Zone 12) North Penn Area Site, Worchester, Pennsylvania, Region 3. CERCLIS No. PAD057152365. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 29 Sep 1988. 8p. Available from NTIS, PC A02/MF A01.

The Transicoil Inc. (Zone 12) North Penn Area Site consists of a manufacturing site for DC and synchro electric motors for commercial and defense uses. An on-site underground storage tank was used for waste oil and hazardous substances. On-site cesspools were used for sanitary waste disposal. Identified contaminants of concern to data include trichloroethylene (TCE), 1,1,1-trichloroethane, tetrachloroethylene (PCE), cis-1,2-dichloroethylene, 1,1-dichloroethane, and 1,1-dichloroethylene in well water and TCE, PCE, and 1,1,1-trichloroethane in soil. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via ingestion of contaminated groundwater, surface water, or other materials or of plants or animals which have accumulated contaminants from the site; contaminated soil ingestion by children; inhalation of compounds volatilized from contaminated groundwater during household uses, of contaminants volatilized from the site, or of contaminants carried in reentrained dust; and dermal contact with contaminated groundwater, surface water, soil, or other materials.

24686 (PB–90-144676/XAB) **Health assessment for Tyson's Dump National Priorities List (NPL) Site, Montgomery County, Pennsylvania, Region 3. CERCLIS No. PAD980692024. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 8 Dec 1988. 16p. Available from NTIS, PC A03/MF A01.

Tyson's Dump National Priorities List site is an abandoned septic and chemical waste disposal site located within an old sandstone quarry. Several unlined lagoons were formerly used to store various industrial, municipal, and chemical wastes. Previous waste disposal operations have resulted in contamination of soil, groundwater, sediment, and surface water with numerous organic compounds. The site is located near the Schuylkill River which is used as the water source for 3 downstream public water systems. High concentrations of contaminants remain in on-site surface and subsurface soils and pose a potential health concern. The site is of potential public health concern because of the risk of human health resulting from possible exposure via ingestion, inhalation, and dermal contact with surface water, groundwater, soil, and sediment to hazardous substances at concentrations that may result in adverse health effects. Contaminants of concern on-site in surface soil are: 1,2,3-trichloropropane, and xylenes. In subsurface soil contaminants are: 1,2,3-trichloropropane, tetrachloroethene, and xylenes. In groundwater contaminants are: 1,2,3-trichloropropane, tetrachloroethene, toluene, xylenes, benzene, chlorobenzene, ethylbenzene, trichloroethene, manganese, barium, lead, and arsenic.

24687 (PB–90-144700/XAB) **Health assessment for Welsh Road/Barkman Landfill, Honey Brook, Chester County, Pennsylvania, Region 3. CERCLIS No. PAD980829527. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 2 Dec 1988. 9p. Available from NTIS, PC A02/MF A01.

The Welsh Road/Barkman Landfill site in Honey Brook, Pennsylvania was an unpermitted residential and commercial refuse disposal facility that operated from 1963 to sometime in the 1980s. After 1977, the landfill continued to operate in defiance of legal action to support a closure plan. Various investigations conducted in the 1980s revealed that industrial and hazardous waste had been accepted by the site. The environmental contamination on-site consists of copper, lead, 1,2-dichloropropane, toluene, chloroform and methylene chloride in drummed wastes; and mercury, toluene, dichlorofluoromethane, methylene chloride, trichlorofluoromethane, 5-methyl-2-hexanone, trichloroethylene, 1,2-dichloroethane, and 1,3,5-cycloheptatriene in groundwater. One time sampling indicated the presence of volatile compounds in air (hydrogen chloride and chloroform). The environmental contamination off-site consists of cadmium in sediment; and chloromethane, chloroform, xylenes, dichlorofluoromethane, 1,1-dichloroethane, tetrachloroethylene, p-cresol, toluene, methyl isobutyl ketone, di-n-butyl phthalate, lead, mercury, and zinc in residential well water. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contaminated groundwater, surface water, soil, sediment, and airborne gases, vapors, and particulate.

24688 (PB–90-144718/XAB) **Health assessment for Westinghouse Elevator, Cumberland Township, Adams County, Pennsylvania, Region 3. CERCLIS No. PAD043882281. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 19 Jan 1989. 8p. Available from NTIS, PC A02/MF A01.

The Westinghouse Elevator site in Adams County, Pennsylvania has been in operation since 1968 as an elevator component manufacturing facility. During the process of elevator cab production, parts were passed through a degreasing and paint phase. Sampling of nearby surface water in 1983 revealed contamination with organic solvents. The environmental contamination on-site consists of 1,1,1-trichloroethane and trichloroethylene in surface sludge, soil, surface water, sediment, and groundwater. In addition, 1,1-dichloroethane and 1,1-dichloroethylene were detected in soil. The environmental contamination off-site consists of 1,1,1-trichloroethane, 1,1-dichloroethylene, 1,1-dichloroethane, and trichloroethylene in residential water supply wells. Contaminated groundwater is of primary importance to the site. Private wells have been found to be contaminated and alternate water supplies have been provided. One public supply well has been decommissioned due to contamination. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via contaminated groundwater, surface water, sediment, and possibly on-site soil.

24689 (PB-90-144726/XAB) **Health assessment for Saltville Waste Disposal, Saltville, Virginia, Region 3. CERCLIS No. VAD003127578. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 18 Mar 1987. 16p. Available from NTIS, PC A03/MF A01.

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The Saltville Site (SVS) is located in Smyth County, Virginia. From 1950 to 1972, Olin Company operated an electrolytic chlorine and caustic soda plant on-site. Mercury from one of the electrodes used in the chlorine-caustic process was released with process wastes on-site. It was estimated that between 1951 to 1970, mercury was lost through wastewater and operating procedures at the rate of 100 pounds per day. Sampling results have demonstrated mercury exceeding the FDA action level of 1 part per million in a high percentage of fish caught in this river, which therefore pose a significant public health threat to area residents. In addition, direct contact with contaminated waste pond outfall and contaminated river sediments are potential routes of exposure for area residents. Neither surface water contamination nor mercury volatilization poses a risk to public health.

24690 (PB-90-144734/XAB) **Health assessment for Reeser's Landfill Site, Upper Macungie Township, Haafsville, Pennsylvania, Region 3. CERCLIS No. PAD980829261. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 27 Mar 1989. 10p. Available from NTIS, PC A02/MF A01.

Reeser's Landfill Site is located near Haafsville, Pennsylvania. Between the years 1971 and 1980, the site was an active municipal refuse dump, which accepted domestic, commercial, and industrial wastes from nearby communities. The site was closed in 1980. On-site contamination consists of cadmium in pooled leachate water; and aluminum, manganese, cadmium, and lead in subsurface soils. No significant contaminant concentrations were found in on-site groundwater. In addition, elevated levels of methane may be present on-site. Site-related contamination off-site consists of cadmium, lead, and chromium in various surface waters and cadmium in surface soils near the drainage ditch from the landfill. Based on the monitoring data there does not appear to be documented human exposures to site-related contamination; hence, no public health implications associated with site-related contamination are warranted at this time. However, this evaluation does not apply if the site is rezoned in the future for other uses. The monitoring of groundwater as part of the monitoring measures included in the ROD will allow for further evaluation of any potential leaching of contaminants from the site into the groundwater. Additional public health considerations may be warranted if this monitoring shows future contamination of the aquifer system.

24691 (PB-90-144742/XAB) **Health assessment for Picco Resins Disposal Site (Hercules, Inc.), Jefferson Borough, Pennsylvania, Region 3. CERCLIS No. PAD063766828. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 15 Nov 1988. 7p. Available from NTIS, PC A02/MF A01.

The Picco Resins Disposal site is approximately 40 acres with two disposal areas which were constructed between 1950 and 1964. A dike failure during construction resulted in waste material flowing from the landfill. On-site contamination consists of benzene, toluene, naphthalene in groundwater; trimethyl benzene, isopropylbenzene, naphthalene, and indole in liquid sludges; and lead, naphthalene, phenol, toluene, arsenic, cadmium, selenium, and 2,4-dimethyl phenol in leachate. Volatile organic compounds have been measured in air above leachate seeps at 10 ppm. Off-site contamination consists of napthalene, manganese, and cadmium in surface water. The site poses a minimal public health threat at the present time. Public access to the site, particularly to areas of surface contamination, should be restricted. All but one local resident is served by a public water supply; the remaining people should not be affected by migrating groundwater at the present time. The sole well-using resident should be offered an alternative water source in the event his well is contaminated. There is not enough information provided to evaluate the public health impact of contaminated surface water off-site.

24692 (PB-90-144759/XAB) **Health assessment for Revere Chemical Company National Priorities List (NPL) Site, Revere, Bucks County, Pennsylvania, Region 3. CERCLIS No. PAD051395499. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 20 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

The Revere Chemical Company site was operated from the late 1960s until 1972 as an acid, metal, and plating waste processing facility. It is suspected of also accepting organic solvent waste. The environmental contamination on-site consists of chromium, mercury, lead, arsenic, and cadmium in the surface water of tributaries on the site boundaries; benzoic acid in the sediment; diethylhexylphthalate in the fire pond; trans-1,2-dichloroethylene and 2-butanone in a production well; chromium, nickel, diethylhexylphthalate, and arsenic in soil. Off-site environmental contamination consists of chromium, lead, arsenic, and nickel in the surface water of the tributaries; chromium, lead, hexachlorobenzene, benzoic acid, di-n-octylphthalate, diethylhexylphthalate, and total polynuclear aromatic hydrocarbons in sediment; and diethylhexylphthalate, nickel, lead, and arsenic in residential well water. Even though removal operations were carried out in 1984, subsequent data collections have shown significant contamination present in surface water, soil, and sediment both on- and off-site. Arsenic and nickel levels exceed water quality criteria. Soil and sediment off-site are contaminated with lead and chromium and would be considered a public health concern should they be in areas where children come in contact with them. In addition, the levels of contamination in surface water and sediment may adversely impact edible aquatic organisms making them unfit for human consumption.

24693 (PB-90-144767/XAB) **Health assessment for River Road Landfill, Hermitage, Pennsylvania, Region 3. CERCLIS No. PAD000439083. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 30 Jun 1988. 7p. Available from NTIS, PC A02/MF A01.

The River Road 60-acre municipal landfill, created in 1962, reportedly accepted polychlorinated biphenyl (PCB) waste. PCBs have been detected in the diversion ditch drainage to the Shenango River. Soil samples at the landfill have also shown elevated levels of PCBs. Chloroethane and 1,1-dichloroethane were also found in on-site groundwater. Surface soil, surface water, and groundwater appear to be impacted by the site. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via chemicals in the groundwater migrating off-site into nearby residential wells.

24694 (PB-90-144775/XAB) **Health assessment for Rohm and Haas Landfill, Bristol Township, Pennsylvania, Region 3. CERCLIS No. PAD077883346. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 17 Jan 1989. 9p. Available from NTIS, PC A02/MF A01.

The Rohm and Haas Landfill (RHL) Site is located in the Croydon area of Bristol Township, (Bucks County), Pennsylvania. RHL operated from 1952 to 1975 as a repository for wastes generated

from manufacturing operations. On-site groundwater sampling results have identified benzene, xylene, bis, ether, toluene, trichloroethylene (TCE), butylbenzylphthalate, sodium, and chromium. In addition, DDT was detected in soil. Off-site groundwater sampling results reported TCE, perchloroethylene, and trans-1,2-dichloroethylene. TCE and methylene chloride were identified in off-site surface water and soil respectively. The site is considered to be of public health concern because of the risk to human health caused by the likelihood of human exposure to hazardous substances. Direct contact with, ingestion, and inhalation of contaminated groundwater are the exposure pathways of concern.

24695 (PB–90-144783/XAB) **Health assessment for Route 940 Dump Site, Tobyhanna, Pennsylvania, Region 3. CERCLIS No. PAD981034630. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 10 Apr 1989. 7p. Available from NTIS, PC A02/MF A01.

The Route 940 Dump Site (RDS) is located in Tobyhanna (Monroe County), Pennsylvania. Preliminary on-site sampling results have identified various VOCs in groundwater and soil. They include: methylene chloride, chloroform, 1,1,1-trichloroethane, carbon tetrachloride, trichloroethylene, tetrachloroethylene, benzene, toluene, 1,1-dichloroethene, and 1,2-dichloroethane. Potential environmental pathways include migration of contaminated groundwater, on-site soils, and volatilization of contaminants in ambient air. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances.

24696 (PB–90-144817/XAB) **Health assessment for Spra-Fin Site, North Wales, Pennsylvania, Region 3. CERCLIS No. PAD002498632. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 4 May 1988. 7p. Available from NTIS, PC A02/MF A01.

The Spra-Fin Site is an active metal products facility that has operated on a half-acre site in an urban area of North Wales, Pennsylvania, since 1963. The facility uses trichloroethylene (TCE) in a 100-gallon vapor degreaser. In 1982, 80 cubic yards of TCE-contaminated soil was removed from the area surrounding the storage tank. Environmental sampling to data indicates that the contaminants of concern are volatile organic compounds (VOCs) present in groundwater and soil. The VOCs present in the groundwater include TCE, 1,2-dichloroethylene, vinyl chloride, tetrachloroethylene, 1,1,1-trichloroethane, and chloroform. The primary environmental pathway for the site is contamination of groundwater. Human exposures may result from ingestion, inhalation, and dermal absorption of contaminants in groundwater used for drinking and other household needs, and from inhalation of air-stripped contaminants. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances.

24697 (PB–90-144825/XAB) **Health assessment for William Dick Lagoons, Honeybrook, Pennsylvania, Region 3. CERCLIS No. PAD980537773. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 30 Sep 1988. 7p. Available from NTIS, PC A02/MF A01.

The William Dick Lagoon site consists of three unlined lagoons (approximately 2.5 acres total area) which previously contained over four million gallons of rinse water from cleaning chemical tank trailers. In 1970, two of the lagoons breached and released approximately 300,000 gallons of wastewater into the nearby area and a small tributary. Trichloroethylene, toluene, 4,4-DDE, and polynuclear aromatic hydrocarbons have been reported in the soil on the site. Trichloroethylene was detected in a nearby spring, previously used as a water source by a small number of residents. Potential human exposure pathways include ingestion of contaminated water, dermal exposure to contaminated water and soil, and inhalation of contaminated dust and organics in the contaminated groundwater. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances. However, it does not appear that a human population is currently exposed to site contaminants at levels of health concern.

24698 (PB–90-144833/XAB) **Health assessment for Rentokil Incorporated, Richmond, Virginia, Region 3. CERCLIS No. VAD071040752. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 4 May 1988. 8p. Available from NTIS, PC A02/MF A01.

The Rentokil Inc. site is located near Richmond, Virginia, and is an operating wood preserving facility. PCP and creosote were used at the site until their use was discontinued in 1982. Chemical wastes were disposed of on site in an unlined lagoon until 1983 and were removed in 1987. The principal contaminants of concern at the site are pentachlorophenol, creosote, copper, chromium, arsenic, and dioxin. Contamination of on-site and groundwater has been documented. Ingestion of contaminated groundwater appears to be the human exposure pathway of primary concern, although ingestion of contaminated soil and inhalation of vapors and/or contaminants entrained in fugitive dust are theoretically possible. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of human exposure to hazardous substances.

24699 (PB–90-144841/XAB) **Health assessment for Rhinehart (Aka Winchester) Tire Fire National Priorities List (NPL) Site, Frederick County, Virginia, Region 3. CERCLIS No. VAD980831796. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 17 Apr 1989. 16p. Available from NTIS, PC A03/MF A01.

The Rhinehart (aka Winchester) Tire Fire Site is located near the town of Winchester in Frederick County, Virginia. In October 1983, a fire was started in the tires disposed of on the site. Hot oil was released from the melting and pyrolysis of the tires. This oil made its way to Massey Run, a nearby surface water body. The fire was brought under control within a few days, but continued to smolder for six months. The migration of the oil and the residue from the fire have contaminated the site. The site is of potential public health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse human health effects. Human exposure to heavy metals, polynuclear aromatic hydrocarbons and volatile organic compounds may occur via ingestion, inhalation and dermal absorption of contaminated groundwater, surface water, sediments and soils.

24700 (PNL-SA–17289) **Resolving superimposed groundwater contaminant plumes characterized by chromium, nitrate, uranium, and technetium–99.** Hall, S.H. Pacific Northwest Lab., Richland, WA (USA). Feb 1990. 15p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. (CONF-9002103–1: Ground-water geochemistry conference, Kansas, MO (USA), 20-22 Feb 1990). Order Number DE90008625. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Leakage from a liquid waste storage and solar evaporation basin at the Hanford Site in southeastern Washington State has resulted in a ground-water contaminant plume characterized by nitrate, hexavalent chromium, uranium, and technetium-99. The plume is superimposed on a larger, pre-existing plume extending from upgradient sites and having the same suite of contaminants. However, the relative abundance of contaminant species is quite different for each plume source. Thus, characteristic concentration ratios, rather than concentrations of individual species, are used as geochemical tracers, with emphasis on graphical analysis. Accordingly, it has been possible to resolve the boundaries of the smaller plume and to estimate the contribution of each plume to the observed contamination downgradient from the storage basin. 11 refs., 7 figs.

24701 (UCID–21901) **Temporal behavior of tropical Pacific SST [supersonic transport] in the OSU [Oregon State University] coupled atmosphere: Upper ocean GCM [general circulation models].** Gates, W.L.; Sperber, K.R. Lawrence Livermore National Lab., CA (USA). Feb 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. Order Number DE90008038. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This document discusses the temporal behavior of tropical Pacific supersonic transport (SST) in the Oregon State University (OSU) coupled atmosphere. Upper ocean general circulation models

(GCM). Included are discussions pertaining to the coupled model and the temporal evolution of tropical Pacific SST. 13 refs., 2 figs.

55 BIOMEDICAL SCIENCES, BASIC STUDIES

5502 Biochemistry

Refer also to citation(s) 23641, 23645, 23646, 24111, 24324

24702 (ANL/PPRNT–90-202) **Reaction of benzo[a]pyrene-7,8-dihydrodiol-9,10-epoxide with human hemoglobin and chromatographic resolution of the covalent adducts.** Haugen, D.A.; Myers, S.R. Argonne National Lab., IL (USA). [1990]. 26p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90008705. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The formation of hemoglobin-carcinogen adducts has been proposed as a measure of human exposure to carcinogens. Hemoglobin-carcinogen adducts have been detected in carcinogen-treated animals and in human populations. Although polycyclic aromatic hydrocarbons (PAH) are ubiquitous in the human environment and DNA-PAH adducts have been detected in human tissues, the occurrent of hemoglobin-PAH adducts in humans has not been described. In this study we examined the effects of reaction conditions on the extent of in vitro reaction of human hemoglobin and (+)(anti)-[^{3}H]benzo[a]pyrene-7,8-diol-9,10-epoxide (BPDE), a metabolite largely responsible for the carcinogenic effect of benzo[a]pyrene. The chromatographic properties of the resulting hemoglobin-BPDE adducts were examined by conventional DEAE-cellulose ion-exchange liquid chromatography and by reversed-phase high-performance liquid chromatography. Several adducts were chromatographically resolved from hemoglobin and from the individual globins.

24703 (DOE/ER/13086–T3) **[Molecular mechanism of energy transduction by plant membrane proteins]: Progress report, June 15, 1985–June 15, 1987.** Wisconsin Univ., Madison, WI (USA). 1987. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-83ER13086. Order Number DE90008435. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This progress report discusses the molecular mechanism of energy transduction by plant membrane proteins. Topics include the location of the DCCD-reactive glutamate in the ATP-ase, purification and sequencing of tryptic peptides, inhibition and labeling of the oat root plasma membrane ATP-ase, an immunological analysis of the plasma membrane ATP-ase and molecular cloning of the higher plant plasma membrane ATP-ase structural gene. (KS)

24704 (DOE/ER/13486–T1) **Carbon and hydrogen metabolism of green algae in light and dark: Progress report, November 1, 1988–October 31, 1989.** Brandeis Univ., Waltham, MA (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13486. Order Number DE90008648. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

After adaptation to a hydrogen metabolism, Chlamydomonas reinhardtii can photoanaerobically metabolize acetate with the evolution of H_2 and CO_2. An enzyme profile of the chloroplastic, cytoplasmic, and mitochondrial fractions were obtained with a cellular fractionation procedure that incorporated cell wall removal by autolysine, digestion of the plasmalemma with digitonin and fractionation by differential centrifugation on a Percoll step gradient. The sequence of events leading to the photo-evolution of H_2 from acetate includes the conversion of acetate into succinate via the extraplastidic glyoxylate cycle, the oxidation of succinate to fumarate by chloroplastic succinic dehydrogenase and the oxidation of malate to oxaloacetate in the chloroplast by NAD dependent malate dehydrogenase. The level of potential activity of the enzymes was sufficient to accommodate the observed rate of gas evolution. The isolated darkened chloroplast evolves aerobically CO_2 from glucose indicating a chloroplastic respiratory pathway. Evolution of CO_2 is blocked by mitochondrial inhibitors.

24705 (DOE/ER/60697–T1) **Improved mutagen-testing systems in mice: Progress report, June 1, 1989–May 31, 1990.** Roderick, T.H. Jackson Lab., Bar Harbor, ME (USA). Jan 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER60697. Order Number DE90008772. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The purpose of these experiments is to induce and utilize chromosomal aberrations, particularly inversions, to establish mutagen assay systems. A further purpose is to validate the systems devised and to utilize the inversions in other biomedical studies. A further important purpose is to saturate a region of a specific part of the genome with recessive lethals and detrimentals for fine tune mapping and understanding a segment of mouse chromosome which has a rather precise human homologous segment. A final purpose is to study the nature and developmental timing of the recessive lethals for general developmental understanding as well as an understanding of the general consequences to mammals of recessive lethals and detrimentals. 2 figs., 1 tab.

24706 ATPase activity of the UvrA and UvrAB protein complexes of the Escherichia coli UvrABC endonuclease. Oh, E.Y. (Johns Hopkins Univ., Baltimore, MD (USA)); Claassen, L.; Thiagalingam, S.; Mazur, S.; Grossman, L. *Nucleic Acids Research (UK),* 17(11): 4145-4159 (12 Jun 1989). DOE Contract FG02-86ER60396.

The authors have analyzed the ATPase activity exhibited by the UvrABC DNA repair complex. The UvrA protein is an ATPase whose lack of DNA dependence may be related to the ATP induced monomer-dimer transitions. ATP induced dimerization may be responsible for the enhanced DNA binding activity observed in the presence of ATP. Although the UvrA ATPase is not stimulated by dsDNA, such DNA can modulate the UvrA ATPase activity by decreases in K_m and V_m and alterations in the K_i for ADP and ATP-γ-S. The induction of such changes upon binding to DNA may be necessary for cooperative interactions of UvrA with UvrB that result in a DNA stimulated ATPase for the UvrAB protein complex. The UvrAB ATPase displays unique kinetic profiles that are dependent on the structure of the DNA effector. These kinetic changes correlate with changes in footprinting patterns, the stabilization of protein complexes on DNA damage and with the expression of helicase activity.

24707 The 5S RNA gene minichromosome of Euplotes. Roberson, A.E. (Oak Ridge National Laboratory, TN (USA)); Hauser, L.J.; Olins, D.E.; Wolffe, A.P. *Nucleic Acids Research (UK),* 17(12): 4699-4712 (26 Jun 1989). DOE Contract AC05-84OR21400.

The macronucleus of the ciliated protozoan Euplotes eurystomus contains about 10^6 copies of a single type of 5S ribosomal RNA gene. This 5S gene DNA is only 930 bp long, is flanked by telomeres, and contains a single coding region of 120 bp which serves as a template for transcription in vivo and in vitro. The 5S gene minichromatin possesses four positioned nucleosomes and hypersensitive cleavage sites in the telomeric regions.

24708 A regularly spaced DNA size standard with 10 kbp resolution for pulsed field gel electrophoresis. Cooney, C.A. (Univ. of California School of Medicine, Davis (USA)); Galbraith, J.L.; Bradbury, E.M. *Nucleic Acids Research (UK),* 17(13): 5412 (11 Jul 1989).

In pulsed field gel electrophoresis (PFGE) a lambda ladder (~50 kbp multiples) is a common DNA size standard. Here the authors describe a standard to conveniently size DNA between ladder rungs and to control for anomalies in PFGE DNA mobility. They combine two partial digests of lambda ladders to give a regularly spaced standard with ~10 kbp resolution in the 10 to 200 kbp range. Lambda ladder in solution is partially digested with Apa I stored at 4°C with 20 mM EDTA pH 7.5 and 1% SDS. Bands with the sizes of intact lambda ladder are also produced by two restriction cuts within one lambda polymer. Bands corresponding to intact lambda ladder are more intense and provide convenient reference points.

24709 Protein evolution on rugged landscapes. Macken, C.A. (Los Alamos National Laboratory, NM (USA)); Perelson, A.S. *Proceedings of the National Academy of Sciences of the United States of America (USA),* 86(16): 6191-6195 (Aug 1989).

The authors analyze a mathematical model of protein evolution in which the evolutionary process is viewed as hill-climbing on a random fitness landscape. In studying the structure of such landscapes, they note that a large number of local optima exist, and they calculate the time and number of mutational changes until a protein gets trapped at a local optimum. Such a hill-climbing process may underlie the evolution of antibody molecules by somatic hypermutation.

24710 **Cloning human telomeric DNA fragments into Saccharomyces cerevisiae using a yeast-artificial-chromosome vector.** Riethman, H.C. (Washington Univ. School of Medicine, St. Louis, MO (USA)); Burke, D.T.; Olson, M.V.; Moyzis, R.K.; Meyne, J. *Proceedings of the National Academy of Sciences of the United States of America (USA),* 86(16): 6240-6244 (Aug 1989).

Telomeric fragments of human DNA ranging in size from 50 to 250 kilobases were cloned into Saccharomyces cerevisiae using a yeast-artificial-chromosome (YAC) vector. Six human-telomeric YAC (HTY) strains were selected by virtue of the specific hybridization of their DNA with the human telomeric terminal-repeat sequence $(TTAGGG)_n$, and the telomeric localization of this sequence within each YAC was demonstrated by its sensitivity to nuclease BAL-31. In situ hybridization of DNA from three of these HTY strains with human metaphase chromosomes yielded discrete patterns of hybridization signals at the telomeres of a limited number of human chromosomes, different for each clone. DNA from selected cosmid subclones of one of the HTY strains was used to localize the origin of the cloned telomeric DNA by in situ hybridization to the tip of the long arm of chromosome 7.

24711 **Generalized immunological recognition of the major merozoite surface antigen (gp195) of Plasmodium falciparum.** Chang, S.P. (Univ. of Hawaii, Honolulu (USA)); Hui, G.S.N.; Kato, A.; Siddiqui, W.A. *Proceedings of the National Academy of Sciences of the United States of America (USA),* 86(16): 6343-6347 (Aug 1989).

The antibody response to the Plasmodium falciparum major merozoite surface antigen (gp195) of congenic mouse strains differing in H-2 haplotype has been examined. All seven strains of mice were capable of producing gp195-specific antibodies. Generalized immune recognition of gp195 by mice of diverse H-2 haplotypes distinguished gp195 from the P. falciparum circumsporozoite protein and the 230-kDa and 48/45-kDa gamete surface antigens. However, the H-2 genetic locus appeared to influence the specificity of gp105-specific antibodies. Immunoblot patterns of mouse sera with parasite antigens revealed a complex pattern of reactivity with terminal and intermediate processing fragments of gp195. The majority of immunoblot bands observed were similar for all of the mouse strains; however, there were several strains that additionally recognized a few unique fragments or displayed more intense reactivities with specific processing fragments. These results suggest that while individuals of diverse major histocompatibility complex makeup are capable of recognizing the gp195 antigen, the recognition of specific gp195 B-cell and T-cell epitopes may be under control of the major histocompatibility complex.

24712 **EXAFS structural study of FX, the low-potential Fe-S center in photosystem I.** McDermott, A.E. (Lawrence Berkeley Laboratory, CA (USA)); Yachandra, V.K.; Guiles, R.D.; Sauer, K.; Klein, M.P.; Parrett, K.G.; Golbeck, J.H. *Biochemistry (USA),* 28(20): 8056-8059 (3 Oct 1989).

We present iron extended X-ray absorption fine structure (EXAFS) spectra of a photosystem I core preparation containing FX, the very low potential iron-sulfur cluster in photosystem I. The preparation lacks FA and FB. The amplitude of Fe-Fe backscattering in the EXAFS spectrum indicates that FX may be a [4Fe-4S] cluster and is not a [2Fe-2S] cluster or clusters.

5503 Cytology

24713 (PNL–6100-Pt.4, pp. 43-46) **Removal of radiation damage by subpopulations of plateau-phase Chinese hamster ovary cells.** Nelson, J.M.; Metting, N.F.; Braby, L.A.; Roesch, W.C. Pacific Northwest Lab., Richland, WA (USA). Feb 1987. In *Pacific Northwest Laboratory: Annual report for 1986 to the DOE Office of Energy Research: Part 4, Physical sciences.* Order Number DE87010025. Available from NTIS, PC A04/MF A01.

Specific cellular radiobiology studies are often required to test aspects of the mathematical models developed in the Radiation Dosimetry program. These studies are designed to determine whether specific mathematical expressions, which characterize the expected effect of biochemical mechanisms on observable biological responses, are consistent with the behavior of selected cell lines. Since these tests place stringent requirements on the cellular system, special techniques and culture conditions are required to minimize biological variability. The use of specialized cell populations is providing data on the extent of repair following low doses, and on the changes in the types of damage that can be repaired as the cell progresses toward mitosis. The stationary-phase Chinese hamster ovary (CHO) cells are composed primarily of G(1)-phase cells (83%), with the remainder comprising both G(2) and S phases. Removal of radiation damage by cells was studied in split-dose experiments. To date, we have observed no significant differences in cellular repair rate. This suggests, therefore, that each of the repair processes found in stationary-phase cells is cell-age independent. However, cellular radiation sensitivity does change rapidly and considerably as the cells progress from one phase to the next through the cell cycle. Since the rate of damage removal appears invariant, the change in survival must reflect the efficiency of producing that damage. The experimental data suggest that production of one or another sort of damage probably dominates during specific phases of the cell cycle, while the capacity for removal of all types of damage remains relatively constant.

5504 Genetics

Refer also to citation(s) 24705

5505 Metabolism

Refer also to citation(s) 24020, 24703, 24755, 24771, 24780

5506 Medicine

Refer also to citation(s) 24284

24714 (CEA-CONF–9900) **Modelisation of ^{11}C-L-methionine pet kinetics in the brain of fasted and fed humans.** Mazoyer, B.M.; Levasseur, M.; Syrota, A.; Baron, J.C.; Prenant, C.; Crouzel, M.; Sette, G.; Samson, Y. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Biologie. 1989. 2p. (CONF-8905293–: 14. international symposium on cerebral blood flow and metabolism, Bologne (Italy), 28 May - 2 jun 1989). Order Number DE90762021. Available from NTIS (US Sales Only), PC A02/MF A01.

Despite the known mutiplicity of brain metabolic pathways of Methyl groups, ^{11}C-Methyl-L-Methionine (^{11}C-Met) positron emission tomography (PET) data are usually analyzed using a 3-compartment 3-rate constant model in which it is assumed that only negligible amounts of ^{11}C-labelled metabolites are produced in brain tissue throughout the duration of the PET exam. The goal of this study was to investigate the compatibility of this model with ^{11}C-Met fast kinetic data obtained in the human brain with PET in fasted and fed subjects and to propose possible better alternative models.

24715 (LA-UR–89-3519) **^{13}C and ^{31}P NMR [Nuclear Magnetic Resonance] studies of prostate tumor metabolism.** Sillerud, L.O.; Halliday, K.R.; Freyer, J.P; Griffey, R.H.; Fenoglio-Preiser, C. Los Alamos National Lab., NM (USA). [1989]. 25p. Sponsored by American Cancer Society; U.S. DOE Energy Research; U.S. Department of Health and Human Services; Veterans Administration. DOE Contract W-7405-ENG-36. (CONF-8904327–1: 21. annual Wayne State cancer symposium, Detroit, MI (USA), 13-14 Apr 1989). Order Number DE90002401. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The current research on prostate cancer by NMR spectroscopy and microscopy will most significantly contribute to tumor diagnosis and characterization only if sound biochemical models of tumor metabolism are established and tested. Prior searches focused on

universal markers of malignancy, have to date, revealed no universal markers by any method. It is unlikely that NMRS will succeed where other methods have failed, however, NMR spectroscopy does provide a non-invasive means to analyze multiple compounds simultaneously in vivo. In order to fully evaluate the ability of NMRS to differentiate non-malignant from malignant tissues it is necessary to determine sufficient multiple parameters from specific, well-diagnosed, histological tumor types that, in comparison to normal tissue and non-neoplastic, non-normal pathologies from which the given neoplasm must be differentiated, one has enough degrees of freedom to make a mathematically and statistically significant determination. Confounding factors may consist of tumor heterogeneity arising from regional variations in differentiation, ischemia, necrosis, hemorrhage, inflammation and the presence of intermingled normal tissue. One related aspect of our work is the development of {^{13}C}-^{1}H metabolic imaging of ^{13}C for metabolic characterization, with enhanced spatial localization (46). This should markedly extend the range of potential clinical NMR uses because the spatial variation in prostate metabolism may prove to be just as important in tumor diagnoses as bulk (volume-averaged) properties themselves. It is our hope that NMRS and spectroscopic imaging will reveal a sound correlation between prostate metabolism and tumor properties that will be clinically straightforward and useful for diagnosis.

24716 (LBL–28248) **Stereotactic helium-ion radiosurgery for the treatment of intracranial arteriovenous malformations.** Fabrikant, J.I.; Levy, R.P.; Frankel, K.A.; Phillips, M.H.; Lyman, J.T.; Chuang, F.Y.S.; Steinberg, G.K.; Marks, M.P. Lawrence Berkeley Lab., CA (USA). Dec 1989. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-8906298–3: International workshop on proton and narrow photon beam therapy, Oulu (Finland), 8-10 Jun 1989). Order Number DE90008664. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

One of the more challenging problems of vascular neurosurgery is the management of surgically-inaccessible arteriovenous malformations (AVMs) of the brain. At Lawrence Berkeley Laboratory, we have developed the method of stereotactic heavy-charged-particle (helium-ion) Bragg peak radiosurgery for treatment of inoperable intracranial AVMs in over 300 patients since 1980 [Fabrikant et al. 1989, Fabrikant et al. 1985, Levy et al. 1989]. This report describes patient selection, treatment method, clinical and neuroradiologic results and complications encountered. 4 refs.

24717 (ORNL/FTR–3548) **[Uses of iridium 191 from the osmium 191/iridium 191 generator system]: Foreign trip report, February 27, 1990–March 12, 1990.** Knapp, F.F. Jr. Oak Ridge National Lab., TN (USA). 23 Mar 1990. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008550. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler was an invited speaker at the 30th Commemorative Meeting of the Finnish Society of Nuclear Medicine on March 2–3 in Helsinki, Finland. He described the development, initial clinical applications, and future use of iridium-191m from the osmium-191/-iridium-191m generator system developed at the Oak Ridge National Laboratory (ORNL). He also visited the university hospitals in Kupio and Turku, Finland, and presented seminars on the use of iridium-191m and iodine-123-labeled fatty acids for cardiac studies. He visited the Clinic for Nuclear Medicine in Bonn, West Germany, and the Cyclotron Research Center (CRC) in Liege, Belgium, to coordinate collaborative projects on research and clinical applications of various radiopharmaceuticals.

24718 Blood cell labeling with ^{99m}Tc: Progress and perspectives. Srivastava, S.C. (Brookhaven National Lab., Upton, NY (USA)); Straub, R.F. *Seminars in Nuclear Medicine (USA)*, 20(1): 41-51 (Jan 1990).

Blood cell labeling with ^{99m}Tc has progressed through various developmental phases. In the case of red cell labeling, the science seems to have matured sufficiently, although minor refinements in the procedures will no doubt continue to be made. During the last 3 to 5 years, there has been a resurgence of interest in labeling leukocytes and platelets with ^{99m}Tc. As a result of these efforts, the techniques for these cell types appear to be developing slowly, having finally come out of their infancy. Progress in these directions over the last 3 1/2 years is summarized and discussed in this article. Emerging techniques that offer the promise of combining simplicity and convenience with reliable and reproducible data are highlighted. Mechanisms involved in the various labeling approaches, if studied and understood, are included. Recent efforts on cell labeling with ^{99m}Tc using the monoclonal antibody approach are summarized. Although results in this area are quite preliminary, the monoclonal antibody approach holds the greatest promise for labeling leukocytes and platelets in vivo, and thus overcoming the biggest drawback of current techniques, ie, cell separation and handling before labeling. 78 references.

24719 Comparison of short-lived high-LET alpha-emitting radionuclides lead-212 and bismuth-212 to low-LET X-rays on ovarian carcinoma. Rotmensch, J. (Argonne National Lab., IL (USA)); Atcher, R.W.; Hines, J.; Toohill, M.; Herbst, A.L. *Gynecologic Oncology (USA)*, 35(3): 297-300 (Dec 1989).

We are investigating the potential use of short-lived alpha-emitting radionuclides for the treatment of ovarian carcinoma. These radionuclides transfer dense high ionizing linear energy (high LET) over a short path length without dependence upon cellular oxygen. The alpha-emitting radionuclides chosen were lead-212 and bismuth-212 which are readily available. The radiosensitivities of two ovarian carcinoma cell lines (OVC-1 and OVC-2) was greater with ^{212}Pb and ^{212}Bi than with X-ray therapy. D0, inversely related to the radiosensitivity, was 155 and 240 rads for OVC-1 and OVC-2, respectively. With ^{212}Pb or ^{212}Bi, the slope of the survival curves was steeper. The D0 was 75 and 70 rads after ^{212}Pb and 85 and 95 rads after 212Bi treatment for OVC-1 and OVC-2, respectively. The relative biological effectiveness with alpha irradiation was two to four times greater than with X rays. Unlike low-LET irradiation (i.e., X rays and gamma emitters) the cells had no ability to accumulate or repair sublethal damage. From these experiments it is concluded that a greater therapeutic advantage may be gained with alpha-emitting radionuclides than X rays. Further development of these nuclides may provide for a new form of therapy.

5507 Microbiology

Refer also to citation(s) 23262, 24389

5520 Public Health

Refer also to citation(s) 23719

5530 Agriculture and Food Technology

Refer also to citation(s) 23877

24720 (HCR-CDTN–10) **Radiation sterilization of hydrocortisone acetate.** Charef, A.; Boussaha, A. Haut Commissariat a la Recherche, Algiers (Algeria). Centre de Developpement des Techniques Nucleaires. Sep 1989. 10p. Order Number DE90621671. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The feasibility of using high energy ionizing radiation for the sterilization of hydrocortisone acetate was investigated. Hydrocortisone acetate in the form of powder was exposed to different dose levels of gamma radiation using a Cobalt-60 source. The irradiated samples were examined by various physico-chemical techniques in order to detect possible radiolysis products. It was of interest to know if one could insure sterility and retain biological properties of the drug by suitable choice of radiation dose. The results showed that a 10 KGy radiation dose causes no change in the physico-chemical properties of the drug and is sufficient to obtain contaminant-free product.

56 BIOMEDICAL SCIENCES, APPLIED STUDIES

Refer also to citation(s) 23831

5601 Radiation Effects

Refer also to citation(s) 23596, 23647, 23781, 23792, 24377, 24391, 24713

24721 (CONF-8910367–1) **Application of an in vivo mutagenesis system to assess aminothiol effects on neutron-induced genotoxic damage in mouse spleenocytes.** Basic, I. (Zagreb Univ. (Yugoslavia). Dept. of Animal Physiology); Grdina, D.J.; Lyons, T. Argonne National Lab., IL (USA). [1989]. 6p. Sponsored by U.S. DOE Energy Research; U.S. Department of Health and Human Services. DOE Contract W-31109-ENG-38. CA 37435. From 3. international conference of anticarcinogens and radiation protection; Dubrovnik (Yugoslavia); 15-21 Oct 1989. Order Number DE90007804. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A cloning technique has been developed to quantitate and study *in vivo* somatic mutations at the hypoxanthine-guanine phosphoribosyl transferase (HGPRT) locus in human lymphocytes. In this paper we describe a modification of this assay to quantify HGPRT mutations in mouse spleenocytes. In particular, we have investigated the effects of the aminothiol on mutagenesis induced by single doses of whole body exposures to fission-spectrum neutrons from the JANUS reactor at Argonne National Laboratory. 7 refs., 3 tabs.

24722 (DOE/ER/60836–1) **Immunobiology of experimental host-tumor relationships in osteogenic malignancies: Progress report.** Utah Univ., Salt Lake City, UT (USA). Radiobiology Div. [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER60836. Order Number DE90008884. Available from NTIS, PC A02/MF A01 - OSTI.

Numerous types of cancers are now plaguing mankind. Because of the potential for human exposure to α-emitting particles, the experimental models which investigate the host-tumor relationships of radiation-induced malignancies are important. It is well established that the immunologic responses to most rodent tumors are initiated and/or effectuated by T lymphocytes. The recent elucidation of the biochemical structure of the antigen receptor on T cells has given us new insight into how tumors possessing unique tumor antigens might evade the immune system. Our work on the immunobiology of tumors induced by non-ionizing radiation and chemical carcinogens has recently demonstrated a correlation between MHC molecule expression and the immunogenicity of tumors in a transplanted syngeneic host. Within our proposal we have initiated experiments to: (1) describe the virulence, latency period, and transplantation characteristics of ^{238}Pu, ^{241}Am, and ^{228}Th tumors arising as osteogenic sarcomas and hepatic carcinomas, (2) determine the relationship between inducible expression of MHC Class I molecules by γIFN and in vivo immunogenicity of these isotype-induced tumors, and (3) elucidate any molecular mechanisms responsible for a lack of responsiveness to γIFN or a failure to induce host γIFN production exhibited by virulent tumors. Our study has also been designed to determine whether the immunologic status of a prospective host, at the time of tumor induction, plays any role in the susceptibility to, and nature of, the induced malignancies. Our proposal will test this important relationship in tumor biology using only ^{238}Pu-induced bone and liver tumors in a rodent system.

24723 (FRNC-TH–3468) **Medical surveillance of nuclear power plant workers during reactor shutdown using whole-body counting and excretion analysis.** Le Roux-Desmis, C. Lille-2 Univ., 59 (France). 1987. 177p. (In French). Order Number DE90762019. Available from NTIS (US Sales Only), PC A09/MF A01.

After a review of radioactivity basis and radiation protection principles, the various aspects of medical surveillance of nuclear power plant workers during reactor shutdown, are presented. Internal contamination incidents that happened during 1986-1987 shutdown of Paluel reactor are described. Internal contamination levels are evaluated using whole-body counting and radionuclide determination in feces and urine and compared with dose limits.

24724 (JINR-E–19-88-511) **Prophage λ induction by ionizing radiation of different LETs.** Bonev, M.N.; Kozubek, S.; Krasavin, E.A.; Amirtaev, K.G. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 14p. Order Number DE90621575. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The λ prophage induction caused by γ-irradiation and accelerated heavy ions with different LET was studied in variety Escherichia coli strains. The induction frequency on the dose I(D) shaped a curve with a maximum in the strains which possess recA$^+$/lexA$^+$ genotype. The inductivity of these strains increases as well as LET and an alteration poor $\rightarrow$ rich media does it. Unlike I(D) for recA$^+$/lexA$^+$, the dependence I(D) for recA, lexA and recBC strains was a constant. 15 refs.; 6 figs.; 3 tabs.

24725 (JINR-R–19-88-646) **The model of the production of premutational damages of DNA by ionizing radiations with different linear energy transfer.** Chernenko, L.P.; Kozubek, S.; Krasavin, E.A. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 4p. (In Russian). Order Number DE90621555. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The model of DNA single and double strand breaks production by ionizing radiation of different linear energy transfer proposed earlier is extended to other types of DNA injuries which are important for induced mutagenesis. The production of damaged bases and complex single strand breaks is calculated on the basis of radial distribution of the absorber energy in the track of charged particle. 5 refs.; 1 fig.

24726 (JINR-R–19-88-766) **Dynamics of appearance of locus and suppressor revertants in adenine auxotrophic yeasts incubated on selective medium.** Korogodina, V.L.; Korogodin, V.I.; Fajszi, Cs. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 13p. (In Russian). Order Number DE90621576. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

When auxotrophic cells grown on medium containing the limiting metabolite and transferred to selective medium without this metabolite, the process of appearance of preexisting revertants may last 6-8 days, with the locus revertants appearing more coordinatedly and in shorter time, than the suppressors. Account of both types of revertants is complicated by the occurring of new reversions due to residual growth. The most correct methodics for accounting is: smearing the newly transferred to the selective medium colonies by a glass spatula and counting multiple revertants. This method significantly enhances detectability of preexisting revertants, which usually sharply decreases with increasing the number of cells in the primary colonies above $5x10^5$. 6 refs.; 7 figs.; 2 tabs.

24727 (PB–90-141243/XAB) **Radon risks: Attitudes, perceptions and actions. Risk communication series. Final report.** Sjoeberg, L. Stockholm School of Economics (Sweden). Aug 1989. 106p. Available from NTIS, PC A06/MF A01.

As many as 8 million homes in the United States may have elevated radon levels, with accompanying lung cancer risks several orders of magnitude higher than for most other environmental risks. The U.S. Environmental Protection Program (EPA) does not have clear regulatory authority over radon, so has relied on an information program. Less than 5% of homes have been tested, which is disappointing from a public health stance. The report summarizes the available research on communicating about the risk from radon from the perspective of a psychologist. The research results are critiqued to draw practical conclusions for radon policy and suggest the most important topics for further risk communication research.

24728 (PB–90-145012/XAB) **Occupational radiation protection program. Instruction.** Anderson, J. Office of the Assistant Secretary of Defense (Force Management and Personnel), Washington, DC (USA). 31 Mar 1989. 6p. (DOD-I–6055.8). Available from NTIS, PC A02/MF A01.

The Instruction reissues DoD Instruction 6055.8, September 29, 1987, implements United States Environmental Protection Agency guidelines, January 1987, supplements DoD Directive 1000.3, and updates procedures for the occupational radiation protection program for the Department of Defense.

24729 (PB–90-145988/XAB) **Micronuclei in binucleated lymphocytes of mice following exposure to gamma radiation.** Erexson, G.L.; Kligerman, A.D.; Halperin, E.C.; Honore, G.M.; Allen, J.W. Environmental Protection Agency, Research Triangle Park, NC (USA). c 1989. 7p. (EPA–600/J-89/232). Available from NTIS, PC A02/MF A01.

Pub. in Environmental and Molecular Mutagenesis, Vol. 13, 128-132(1989).

Experiments were designed to investigate the induction of micronuclei (MN) in mouse peripheral blood lymphocytes (PBLs) after in vitro or in vivo exposure to (60)Co gamma radiation. For the in vitro experiments, 4 ml of blood from male C57BL/6J mice were either irradiated in 6 ml Falcon culture tubes as whole blood or isolated to obtain mononuclear leukocytes (MNLs) that were pelleted by centrifugation and then irradiated in RPMI 1640. For the in vivo analysis mice received whole body irradiation, blood was obtained by cardiac puncture, and the MNLs were isolated for each mouse. Exposures were at a rate of 0.82 to 0.90 Gy/min to yield doses of 0.5, 1, 2, 3, or 4 Gy. MNLs were cultured using cytochalasin B for MN analysis in binucleated PBLs. There was a significant dose-dependent increase in MN observed at all doses. Dose-response curves for the in vivo and in vitro whole blood experiment were not significantly different. However, for isolated pelleted MNLs irradiated in vitro, the MN frequency at 4 Gy was less than half that seen in the in vivo experiment. The large difference in MN response is thought to be due to the radioprotective effect of hypoxia.

24730 (PB–90-920999/XAB) **FDA (Food and Drug Administration) compliance program guidance manual. Section 4. Medical and radiological devices. Basic section. (FY-89).** Food and Drug Administration, Rockville, MD (USA). 1989. 672p. (FDA/OMO–90/14D). Available from NTISStanding Order.

Supersedes PB–89-920999. Updates available on Standing Order as PB–90-920900.

The Food and Drug Administration (FDA) Compliance Program Guidance Manual provides a system for issuing and filing program plans and instructions directed to the Food and Drug Administration Field operations for project implementation. Section IV provides those chapters of the Compliance Program Guidance Manual which pertain to the areas of medical and radiological devices. Some of the areas of coverage include laser and sunlamp standards inspections, compliance testing of various radiation-emitting products such as television receivers and microwave ovens, emergency response planning and policy, premarket approval and device manufacturers inspections, device problem reporting, sterilization of devices, and consumer education programs on medical and radiological devices.

24731 (PNL–6100-Pt.4, pp. 29-31) **Radical yields in oriented DNA exposed to high linear-energy-transfer radiation.** Miller, J.H.; Wilson, W.E.; Swenberg, C.E. Pacific Northwest Lab., Richland, WA (USA). Feb 1987. In *Pacific Northwest Laboratory: Annual report for 1986 to the DOE Office of Energy Research: Part 4, Physical sciences.* Order Number DE87010025. Available from NTIS, PC A04/MF A01.

Track structure-based models are being developed to calculate the yield of free radical species in oriented DNA fibers exposed to ionizing radiation with large LET. Experiments performed at Armed Forces Radiobiology Research Institute (AFRRI) show an unusual effect: radical yields detected by electron spin resonance (ESR) at 77°K depend on the relative orientation of the axis of the DNA molecules to the flux of ionizing particles. When a neutron flux is incident perpendicular to the DNA, ESR spectra are consistent with the production of roughly equal amounts of thymine anion and guanine cation. However, when the sample is irradiated with the neutron flux approximately parallel to the DNA axis, yields of thymine anion and guanine cation are reduced and a new ESR signal is seen. The amount of energy absorbed in DNA relative to that absorbed in the aqueous matrix of the fibers is primarily determined by their respective volume and is independent of orientation. Consequently, the orientation dependence of radical yields must be related to the spatial distribution of energy deposition events rather than to the total amount of energy absorbed in DNA. From the analysis of kinetic data it has been concluded that TH is produced by thermally activated proton transfer to thymine anion; water of hydration is the most likely proton source; and the reaction has a distribution of activation energies between 0.2 and 0.7 eV. Averaged over a distribution of activation energies the authors model predicts that the yield of TH in the parallel irradiation geometry will be about a factor of 10 larger than the yield when DNA is irradiated by a flux of 1-MeV protons that is perpendicular to its helical axis. Although this result is in qualitative agreement with the experiments performed at AFRRI, more calculations are required before a quantitative comparison can be make.

24732 (PNL–6100-Pt.4, pp. 37-38) **Characteristics of repair following very low doses.** Braby, L.A.; Metting, N.F.; Nelson, J.M. Pacific Northwest Lab., Richland, WA (USA). Feb 1987. In *Pacific Northwest Laboratory: Annual report for 1986 to the DOE Office of Energy Research: Part 4, Physical sciences.* Order Number DE87010025. Available from NTIS, PC A04/MF A01.

The effects of ionizing radiation on living systems being with the physical processes of energy deposition and develop through many stages of chemical reaction and biological response. The modeling effort attempts to organize the available data and theories of all of these stages into self-consistent models that can be compared and tested. In some cases, important differences among models result in only small differences in cell survival within the ranges of dose and dose rate that are normally investigated. To overcome this limitation, new ways of irradiating cells at extremes of dose rate, or ways of evaluating the effects of very small doses, are developed. Mathematical modeling and cellular studies complement each other. It has recently been found that some mechanisms are not adequate to account for the interaction of dose and repair time as they affect the reproductive survival of plateau-phase Chinese hamster ovary (CHO) cells. Repair of radiation-induced cellular damage plays a central role in the survival of cells exposed to doses of 1 Gy or more. This repair is responsible for the dose rate, split-dose and delayed plating effect and can be evaluated. Because split-dose and dose-rate experiments involve repair during irradiation and delayed plating experiments involve repair after irradiation is completed, it was originally thought that different repair processes were involved. It is now clear that this is not necessarily the case. Appropriately designed models can account for observed effects at conventional doses (1 Gy or more) whether they assume all damage is lethal unless repaired or some damage is innocuous unless it interacts with additional damage. The fact that the survival following a plating delay is always less than the survival following immediate plating at low doses indicates that the damage produced is probably not potentially lethal.

24733 (PNL–6100-Pt.4, pp. 38-40) **Role of repair saturation in the response of plateau-phase Chinese hamster ovary cells.** Braby, L.A.; Nelson, J.M.; Metting, N.F. Pacific Northwest Lab., Richland, WA (USA). Feb 1987. In *Pacific Northwest Laboratory: Annual report for 1986 to the DOE Office of Energy Research: Part 4, Physical sciences.* Order Number DE87010025. Available from NTIS, PC A04/MF A01.

Two repair rates are seen in split-dose experiments on starved plateau-phase CHO cells. It has been assumed that this indicates two different processes repairing two distinct types of sublethal damage. However results of experiments at different dose levels are not consistent with models that assume that the damage is entirely sublethal. Another hypothesis that has been considered is the saturation of a repair mechanism having a limited pool of repair enzymes. Such saturation phenomena have been observed in biochemical repair studies and have thus formed the basis for a model of cellular response, which was shown to be capable of producing dose response curves in good agreement with experimental observations. This model can be extended to account for both dose-rate and split-dose effects.

24734 (PNL–6100-Pt.4, pp. 40-41) **Repair studies with Chlamydomonas Reinhardi and high-linear energy transfer radiations.** Braby, L.A.; Jacobson, B.S. Pacific Northwest Lab., Richland, WA (USA). Feb 1987. In *Pacific Northwest Laboratory: Annual report for 1986 to the DOE Office of Energy Research: Part 4, Physical sciences.* Order Number DE87010025. Available from NTIS, PC A04/MF A01.

High linear energy transfer (LET) has been used to study the effect of track structure on the rate of repair in Chlamydomonas.

Data has been collected on the dose-effect relationship and repair rate for electron, proton, and deuteron irradiations. The use of 5-fluorodeoxyuradine (FUdR) inhibition of chloroplast deoxyribonucleic acid (DNA) production to reduce the redundancy in this extranuclear genome and to determine its effect on cell survival and repair kinetics has been explored. However it appears that the chloroplast DNA of FUdR-treated cells is such a small fraction of the sensitive material within the cell that it cannot be used in kinetic studies with survival as the endpoint. The repair of damage produced by fast ions apparently involves a complex mixture of processes. Repair times are essentially independent of LET, but there is an increase in irreparable damage with increasing LET.

24735 (PNL–6100-Pt.4, pp. 49-53) **Modulation of radiation-induced mutation frequencies and DNA synthesis by deoxycytidine in Chinese hamster ovary cells.** Newman, C.N. Pacific Northwest Lab., Richland, WA (USA). Feb 1987. In *Pacific Northwest Laboratory: Annual report for 1986 to the DOE Office of Energy Research: Part 4, Physical sciences.* Order Number DE87010025. Available from NTIS, PC A04/MF A01.

The goal of this project is to elucidate and model the impact of perturbations in cellular metabolism on the cellular response to DNA damage. Previously reported experiments established roles for DNA synthesis and the inhibition of DNA synthesis in the expression of radiation-induced mutations. This year, these experiments were continued and the study was expanded. Two different Chinese hamster ovary (CHO) cell lines were examined. Experimental measurements were obtained for cells in one of two growth media: (1) medium A, which consisted of Ham's F-12 containing 10% fetal calf serum; or (2) medium B, which consisted of medium A containing 2 mm deoxycytidine (CdR). The presence of CdR differentially affected the nature of DNA replication, the inhibition of replication by radiation, and the corresponding mutation frequency responses. Results suggest that the effect of CdR on mutation-induction is not locus-specific. Moreover, the phenomenal reduction in the mutation response in the presence of CdR is also seen following exposure to ionizing radiation, which implies that the effect of CdR is not mutagen-specific. Time-dependent changes in profiles of pulse-labeled DNA on alkaline sucrose gradients were employed to measure and compare nascent DNA chain growth processes in the two media. Results suggest that a more rapid DNA chain elongation and/or replicon mutation rate occurs in cells in medium B. In contrast, the sedimentation of one pulse-labeled CHO cell line DNA is always greater when cells are grown in medium A. UV radiation appears to inhibit postirradiation replicon initiation events and results in reduced mutation frequencies when cells are grown in the medium that promotes the more rapid rate of polymerization.

24736 (PNL-SA–17037) **The next step in radiation protection: Controling risk rather than dose.** Merwin, S.E.; Traub, R.J.; Faust, L.G. Pacific Northwest Lab., Richland, WA (USA). [1990]. 11p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. (CONF-900246–5: 23. Health Physics Society midyear topical symposium on risk analysis, Atlantic City, NJ (USA), 4-9 Feb 1990). Order Number DE90008629. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Although the efforts of nuclear facilities and regulatory agencies in controlling, monitoring, and recording doses received by individual workers have resulted in a very small mean individual annual dose, the ultimate goal should be to control the risks from radiation doses rather than the doses themselves. This is desirable for two primary reasons: first, a specific radiation dose does not imply a specific level of risk; second, radiation doses cannot be compared directly to levels of other hazards. Controlling radiation doses may thus be overemphasized compared to other hazards that exist in the workplace. Using a modified version of the computer code RISKAP, it is demonstrated that the overall risks to workers would be reduced if risk limits rather than dose limits were promulgated. This approach could allow all occupational risks to be evaluated on the same basis and could indicate how resources should be allocated to achieve optimal reductions in overall risks. 14 refs., 2 figs., 2 tabs.

24737 **Comparative skeletal distribution of Am and Pu in man, monkey, and baboon.** Lynch, T.P. (Pacific Northwest Laboratory, Richland, WA (USA)); Kathren, R.L.; Dagle, G.E.; McInroy, J.F. *Health Physics (USA),* : 81-88 (1989).

The skeletal distribution of Am and Pu in four human cases was compared with the skeletal distributions of these radioelements in baboons and monkeys. Excellent agreement was noted among the four human cases; data were available for Am in all four and Pu in three. A statistically significant correlation was found between the ^{241}Am and $^{239}Pu + {}^{240}Pu$ skeletal distributions in the humans and those in nonhuman primates. Trabecular bone had the highest concentrations of ^{241}Am and $^{239+240}Pu$ in humans, baboons, and monkeys. Scaling factors are proposed to convert the percentages of skeletal activity in animal bones to the corresponding percentages in the bones of the human skeleton.

24738 **Estimation of human gonadal Pu and Ce concentrations from animal data.** Thomas, R.G. (Office of Health and Environmental Research, Washington, DC (USA)); Durbin, P.W.; McInroy, J.F.; Healy, J.W. *Health Physics (USA),* : 97-107 (1989).

Data were obtained from the literature for gonad and body weights and for the Pu or Ce content of the gonads and body at death for several laboratory animal species, five human Pu injection cases, and 731 human adults exposed environmentally to Pu in fallout. Data for Pu concentration in gonads, liver, and bone samples of 59 male and five female occupational Pu cases (including four completely analyzed whole bodies) were obtained from the U.S. Transuranium Registry. A logarithmic function was used to relate fractional Pu or Ce concentration in testes and ovaries to body weight of the animals and to predict fractional Pu or Ce concentrations in human gonads, [Pu]G . PuB-1 = aBWb, where [Pu]G or [Ce]G is the nuclide concentration in gonads (Bq g-1 of wet weight), PuB or CeB is the nuclide content of the body at death, and BW is body weight (kg). The fractional Pu and Ce concentrations in both the testes and ovaries are inverse and nearly linear functions of body weight. The regression lines of fractional Pu or Ce concentration in testes and ovaries have similar slopes (b = -1.07 +/- 0.14); however, the nuclide concentrations (coefficient a) in ovaries are six times greater than in testes. Extrapolation of the animal data yielded fractional Pu concentrations in human testes and ovaries that agree with those calculated for the occupational cases and those recommended by the International Commission on Radiological Protection. The good agreement between the fractional concentrations of Pu and Ce in the testes and in the ovaries suggests that these data can be substituted in metabolic models of chemically similar elements for which gonadal data are scarce.

24739 **Factors affecting the placental transfer of actinides.** Sikov, M.R. (Pacific Northwest Laboratory, Richland, WA (USA)); Kelman, B.J. *Health Physics (USA),* : 109-114 (1989).

The primary goal of this paper is to consider factors that affect the availability and transport of actinides from maternal blood, through the placenta, to the conceptus. These factors, of particular importance in scaling results from animals to man, include the route and temporal pattern of administration, the mass and physicochemical state of material administered, metabolism of the pregnant animal and fetal organs or tissue, and species-specific changes in placental structure relative to stage of gestation at exposure. Preliminary concepts for descriptive and kinetic models are proposed to integrate these results, to identify additional information required for developing more comprehensive models, and to provide a basis for scaling to human pregnancies for purposes of radiation dosimetry.

24740 **Human respiratory tract model for radiological protection: A revision of the ICRP Dosimetric Model for the Respiratory System.** Bair, W.J. (Pacific Northwest Laboratory, Richland, WA (USA)). *Health Physics (USA),* : 249-52; discussion 252-3 (1989).

In 1984, the International Commission on Radiological Protection (ICRP) appointed a task group of Committee 2 to review and revise, as necessary, the ICRP Dosimetric Model for the Respiratory System. The model was originally published in 1966, modified slightly in Publication No. 19, and again in Publication No. 30 (in 1979). The task group concluded that research during the past 20 y suggested certain deficiencies in the ICRP Dosimetric Model for

the Respiratory System. Research has also provided sufficient information for a revision of the model. The task group's approach has been to review, in depth, morphology and physiology of the respiratory tract; deposition of inhaled particles in the respiratory tract; clearance of deposited materials; and the nature and specific sites of damage to the respiratory tract caused by inhaled radioactive substances. This review has led to a redefinition of the regions of the respiratory tract for dosimetric purposes. The redefinition has a morphologic and physiological basis and is consistent with observed deposition and clearance of particles and with resultant pathology. Regions, as revised, are the extrathoracic (E-T) region, comprising the nasal and oral regions, the pharynx, larynx, and upper part of the trachea; the fast-clearing thoracic region (T[f]), comprising the remainder of the trachea and bronchi; and the slow-clearing thoracic region (T[s]), comprising the bronchioles, alveoli, and thoracic lymph nodes. A task group report will include models for calculating radiation doses to these regions of the respiratory tract following inhalation of representative alpha-, beta-, and gamma-emitting particulate and gaseous radionuclides. The models may be implemented as a package of computer codes available to a wide range of users.

24741 Modeling the biological effectiveness of high-LET radiation. Miller, J.H. (Pacific Northwest Laboratory, Richland, WA (USA)); Wilson, W.E. *Health Physics (USA),* : 363-367 (1989).

Reevaluation of neutron exposures to atomic bomb survivors has greatly reduced the significance of that data base for estimating the relative biological effectiveness of radiations with high linear energy transfer (LET). Consequently, greater emphasis is being given to animal data and mechanistic studies at the cellular and molecular level in assessing the role of radiation quality in the health effects of low-level radiation exposure. We are investigating the spatial patterns of energy deposited in DNA by ionizing radiation and their influence on cell killing and mutation induction. Our basic hypothesis is that high ionization density increases the probability that radiation-induced DNA damage will be unrepairable or misrepaired. This paper discusses the use of computer simulation to investigate damage induced in DNA by the decay of incorporated 125I.

24742 Analyzing the role of biochemical processes in determining response to ionizing radiations. Nelson, J.M. (Pacific Northwest Laboratory, Richland, WA (USA)); Braby, L.A.; Metting, N.F.; Roesch, W.C. *Health Physics (USA),* : 369-376 (1989).

The interaction of biochemical processes and radiation damage appears to play a major role in determining long-term biological effects. It is responsible for both the removal of radiation-induced alterations in macromolecules and for the time-dependent changes in survival of irradiated cells. Restoration of macromolecules by such means as the rejoining of strand breaks in DNA suggests a variety of possible mechanisms which could lead to the observed enhancement of cell survival. However, even though a number of molecular repair mechanisms have been identified, specific links between any such mechanisms and a subsequent modification of cell survival have proved difficult, if not impossible, to demonstrate. Models of cellular response provide a means of attempting to establish this connection. Although details of radiation chemistry, chromatin structure, enzymatic repair, molecular genetics, and cell cycle kinetics are generally simplified, each individual model incorporates features based on a set of assumed mechanisms. For example, one group of models assumes that all damage is potentially lethal, while another assumes that part of the damage is sublethal. Using split-dose, dose-rate, and delayed-plating techniques, we have demonstrated two distinct components of repair in plateau-phase Chinese hamster ovary cells. One process has a characteristic time of about 1 h; the other, about 18 h. In both cases, the reaction rates and the fractions of damage repaired appear to be independent of the initial amounts of damage produced. These observations suggest that none of the simpler models adequately describes cell inactivation; i.e., reproductive death is inconsistent with all assumptions regarding any of them. Consequently, more-complex models involving combinations of sublethal and potentially lethal damage or multiple-step damage processes may be required.

24743 Time-related factors in the study of risks in animals and humans. Gilbert, E.S. (Pacific Northwest Laboratory, Richland, WA (USA)); Park, J.F.; Buschbom, R.L. *Health Physics (USA),* : 379-84; discussion 384-5 (1989).

Data from epidemiological studies of humans exposed to potentially harmful substances are usually analyzed using methods that account for the dependence of risks on time-related factors such as age and follow-up period. Recently developed statistical procedures allow modeling of the age-specific risks as a function of dose as well as factors such as age at exposure, time since exposure, exposure duration, and dose rate. These procedures potentially allow more rigorous inferences and clearer understanding of the patterns of risk observed in epidemiological studies than has been available in the past. Statistical procedures that consider time-related factors can also be applied to laboratory animal data, providing information that is useful for the problems involved in extrapolating from animal studies to humans. By applying such procedures to data on exposure to the same substance in different species (including humans) or to different substances in the same species, better understanding of the relationship of risks across species and across substances can be achieved. In addition, such statistical procedures allow appropriate treatment of exposure that is accumulated over time and lead to improved understanding of patterns of risk over time. The approach is illustrated using data from a lifespan study of beagle dogs exposed to inhaled Pu.

24744 Determination of pyrimidine dimers in DNA by high-performance liquid chromatography/gas chromatography and electron capture detection. Ramsey, R.S. (Oak Ridge National Lab., TN (USA)); Ho, C. *Analytical Biochemistry (USA),* 182(2): 424-431 (1 Nov 1989).

Exposure of DNA to uv radiation results in the formation of a number of photoproducts including the cyclobutyl pyrimidine dimers. At low uv fluences the concentrations of these dimeric compounds are only a small fraction of the corresponding DNA pyrimidine concentration (e.g., as low as 0.02% or less of the total thymine content). Sensitive methods of analysis are therefore required for accurate determinations. Analytical methodology based upon HPLC fractionation and electrophore labeling followed by GC/electron capture detection (ECD) has been developed to quantitate these species. Separation of thymine-thymine, thymine-uracil, and uracil-uracil from the monomeric bases and from other constituents present in acid-hydrolyzed DNA is achieved by reversed-phase HPLC. Isolation of the dimeric fractions is followed by off-line derivatization to form pentafluorobenzyl products for analysis by GC/ECD. All active hydrogens are alkylated, yielding products with high response factors and detection limits in the low femtomole range. The overall analytical scheme for the determination of pyrimidine dimers in DNA is presented.

24745 HUMTRN and EFFECTS: Age and sex specific dosimetric and physiological human population dynamics models for dose assessment. Gallegos, A.F. (Los Alamos National Lab., NM (USA)); Wenzel, W.J. *Health Physics (USA),* : 443-453 (1989).

A human simulation model called HUMTRN and a population risk assessment model called EFFECTS were developed at Los Alamos National Laboratory as a major component of the BIOTRAN environmental risk assessment model. HUMTRN simulates growth using dietary and physiological characteristics and kinetics of radionuclides to predict radiation doses to selected organs of both sexes in different age groups. The model called EFFECTS was interfaced with output from HUMTRN to predict cancer risks in a dynamic human population. EFFECTS is based on the National Research Council Committee on the Biological Effects of Ionizing Radiation (BEIR)-III radiation cancer mortality estimates from the U.S. population mortality and natality estimates for both sexes between the ages of 1 and 70. These models track radiation intake from air, water, and food, calculate uptake in major growing organs, and estimate cancer mortality risks. This report documents the use of an IBM Personal Computer AT to run HUMTRN and EFFECTS. Air, water, and food contaminant concentrations are provided as input to HUMTRN, which then provides input for EFFECTS. The limitations of this approach are also discussed.

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24746 (AD-A-215176/9/XAB) **Toxic Hazards Research Unit-1988. Annual report, October 1987-September 1988.** Kautzman, R.S.; Conolly, R.B. Northrop Services, Inc./Environmental Sciences, Dayton, OH (USA). Jul 1989. 267p. Available from NTIS, PC A12/MF A02.

This report has been prepared as a review of the activities of the Toxic Hazards Research Unit for the period of October 1987 through September 1988. Research activities focused on the toxicity evaluations of aerospace chemicals and materials, studies on Installation Restoration Program chemicals, studies on Air Force Fuels, development of physiologically based pharmacokinetic and pharmacodynamic models, studies of chemical defense materials and associated training simulants, subchronic studies on materials of interest to the Navy, and assessment of the delayed neurotoxicity potential of shipboard hydraulic fluid samples. The review of the studies presented here includes partially completed efforts that will be reported further in subsequent annual reports.

24747 (AD-A-215465/6/XAB) **Workshop on the effects of combined fire products on human physiological and psychological performance. Held in Groton, Connecticut on November 16-18, 87. Final report for period ending November 1987.** Callahan, A.B.; Harvey, C.A.; Pohler, C.H. Naval Submarine Medical Research Lab., Groton, CT (USA). 9 Aug 1989. 12p. (NSMRL-SP-89-4). Available from NTIS, PC A03/MF A01.

This report summarizes the discussion and conclusions reached at a Workshop on the Effects of Combined Fire Products on Human Physiological and Psychological Performance. The workshop was held at the Naval Submarine Medical Research Laboratory on 16-18 Nov 1987.

24748 (AD-A-215648/7/XAB) **New approach for evaluating biological toxicity at aquatic hazardous-waste sites. Professional paper.** Johnston, R.K.; Lapota, D. Naval Ocean Systems Center, San Diego, CA (USA). Aug 1989. 16p. Available from NTIS, PC A03/MF A01.

Pub. in Proceedings of the Symposium on coastal and Ocean Management/ASCE (6th), 422-436(11-14 Jul 1989).

The impact of hazardous wastes on aquatic systems is an important consideration in the Navy's Installation Restoration Program. A majority of the Navy's assets are located in coastal and estuarine areas which are complex, dynamic ecosystems, important both economically and ecologically. The purpose of this paper is to survey methods available to assess the toxicity of hazardous wastes on aquatic ecosystems, identify the most practical methods for use in determining the potential impact of hazardous waste sites and the selection of remedial alternatives. Current techniques for measuring toxicity using bacteria, phytoplankton, crustaceans, molluscs, and other organisms are reviewed. These methods can be used in developing the information required by the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) during the Remedial Investigation and Feasibility Study (RI/FS) process. There is a need to develop new and innovative bioassays for assessing toxicity. Once these tests and their results are compared, it may be practical to use only a few species for routine monitoring.

24749 (DOE/ER/60784-1) **Basic theory and methods of dosimetry for use in risk assessment of genotoxic chemicals: Annual technical progress report.** Stockholm Univ. (Sweden). Dept. of Radiobiology. 15 Feb 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER60784. Order Number DE90008654. Available from NTIS, PC A02/MF A01; OSTI; INIS.

Considering difficulties of employing the wanted persons in the middle of a university semester (in Sweden January–June), and considering the reduced amount available for the first project year (to March 1, 1990), emphasis has been laid on planning and organization, real work being concentrated mainly to the second half of the project year. A few part studies have been initiated, considered to constitute essential components in the overall project, the aims of which may be formulated: Unprejudiced analysis of the usefulness of molecular-biological data, and specification of which data are needed, for the prediction of risk of cancer due to exposure to environmental genotoxic agents (chemicals and radiations). It is self-evident that a project with such aims also has to involve studies of current models for risk estimation, particularly for the understanding of deviations of observed excess incidence from predicted risks.

24750 (PB-90-135203/XAB) **Effect of microbial concentration on biodegradation rates of phenols.** Vaishnav, D.D.; Babeu, L.; Korthals, E.T. Wisconsin Univ., Superior, WI (USA). Center for Lake Superior Environmental Studies. c 1989. 9p. Available from NTIS, PC A02/MF A01.

Pub. in Jnl. of Industrial Microbiology, Vol. 4, 307-314(1989).

Biodegradation rates of 12 phenols were measured with respect to acclimated microbial biomass ranging from 23,000 to 23 x 10 to the 8th power cells/l. Rates ranged between 0.02 m/l/day for 1.6 mg/l p-bromophenol exposed to 23,000 x 10 to the fourth power cells/l and 1.41 mg/l/day for 3.2 mg/l p-methylphenol exposed to 2.3 x 10 to the 8th power cells/l. Generally, rates for all phenols were first-order in substrate concentration and zero-order in biomass concentration. Bromophenol biodegradation was preceded by lag periods of varying lengths and to a small extent the rate was dependent on microbial biomass. Results from the study suggest chemical biodegradation generally exhibits pseudo-first- and occasionally, second-order kinetics.

24751 (PB-90-135245/XAB) **Prediction of biodegradability for selected organic chemicals.** Babeu, L.; Vaishnav, D.D. Wisconsin Univ., Superior, WI (USA). Center for Lake Superior Environmental Studies. c 1987. 11p. Available from NTIS, PC A03/MF A01.

Pub. in Jnl. of Industrial Microbiology, Vol. 2, 107-115(1987).

The 5-day BODs of 45 organic chemicals were determined using acclimated mixed microbial cultures. These chemicals included alcohols, acids, esters, ketones, aromatics and miscellaneous compounds. The BOD data were correlated with water solubilities, log of l-octanol/water partition coefficients, molar refractivities and volumes, melting (m.p.) and boiling points, number of carbon (C No.), hydrogen and oxygen atoms, molecular weights, and theoretical (Th) BODs of chemicals. Linear and second-order polynomial regression analyses were used; the latter was also attempted with two or more independent variables. All prediction equations were compared for statistical merits. The acclimation potential of an autochthonous microbial community cannot yet be predicted, but the study demonstrates that the process of active biodegradation for structurally dissimilar chemicals appears to correlate quantitatively with certain physiochemical parameters.

24752 (PB-90-136136/XAB) **Health assessment for Norwood PCB, Norwood, Massachusetts, Region 1. CERCLIS No. MAD980670566. Preliminary report.** Agency for Toxic Substances

and Disease Registry, Atlanta, GA (USA). 28 Jul 1983. 7p. Available from NTIS, PC A02/MF A01.

A table gives the results of PCB determinations in serum samples taken from residents in the proximity of the PCB site in Norwood, MA. These samples were obtained from individuals with the highest probability of exposure to the PCB contaminated site (based on epidemiological questionnaire). The results are well within the concentration range that found in general populations in other states, such as Iowa and Michigan.

24753 (PB–90-140674/XAB) **Anaerobic biodegradation of o-, m- and p-cresol by sulfate-reducing bacterial enrichment cultures obtained from a shallow anoxic aquifer.** Suflita, J.M.; Liang, L.; Saxena, A. Oklahoma Univ., Norman, OK (USA). Dept. of Botany and Microbiology. c 1989. 13p. Available from NTIS, PC A03/MF A01.

Pub. in Jnl. of Industrial Microbiology, Vol. 4, No. 4, 255-266(Jul 1989).

Sulfate-reducing bacterial enrichments were obtained from a shallow anoxic aquifer for their ability to metabolize either o-, m-, or p-cresol. GC/MS and simultaneous adaptation experiments suggested that the anaerobic decomposition of p-cresol proceeds by the initial oxidation of the aryl methyl group to form p-hydroxybenzoic acid. The intermediate was then converted to benzoic acid. Benzoic acid and a hydroxybenzaldehyde were also found in spent culture fluids from an o-cresol-degrading enrichment culture. The result, in addition to others, suggested that o-cresol may also be anaerobically degraded by the oxidation of the methyl substituent. An alternate pathway for anaerobic m-cresol decomposition might exist. Enrichment cultures obtained with either p- or o-cresol degraded both of these substrates but not m-cresol. In contrast a m-cresol enrichment culture did not metabolize the ortho or para isomers. Anaerobic biodegradation in all enrichment cultures was inhibited by molybdate and oxygen, and was dependent on the presence of sulfate as a terminal electron acceptor.

24754 (PB–90-140732/XAB) **Effect of zinc exposure on subsequent acute tolerance to heavy metals in rainbow trout.** Anadu, D.I.; Chapman, G.A.; Curtis, L.R.; Tubb, R.A. Environmental Protection Agency, Newport, OR (USA). Mark O. Hatfield Marine Science Center. c 1989. 10p. (EPA–600/J-89/177). Available from NTIS, PC A02/MF A01.

Pub. in Bulletin of Environmental Contamination and Toxicology, Vol. 43, 329-336 (1989).

Fish usually show increased tolerance to metals in solution if previously given an opportunity to acclimate to near lethal concentrations of the metal. Tolerance has been correlated with an increase in tissue metallothionein (MT). The purposes of the tests described were to investigate the potential for increased tolerance to zinc; to evaluate correlations between tolerance and liver MT level; to go beyond simple one-step acclimation by increasing the acclimation level as tolerance developed; to measure loss of tolerance following transfer of acclimated fish to control water; and to determine if zinc acclimation led to increased tolerance to copper and cadmium.

24755 (PB–90-140799/XAB) **Formation of cigarette smoke-induced DNA adducts in the rat lung and nasal mucosa.** Gupta, R.C.; Sopori, M.L.; Gairola, C.G. Baylor Coll. of Medicine, Houston, TX (USA). Dept. of Pharmacology. c 1989. 7p. Available from NTIS, PC A02/MF A01.

Pub. in Cancer Research 49, 1916-1920(15 Apr 1989).

The formation of DNA adducts in the nasal, lung, and liver tissues of rats exposed daily to fresh smoke from a University of Kentucky reference cigarette (2R1) for up to 40 weeks was examined. The amount of smoke total particulate matter (TPM) inhaled and the blood carboxyhemoglobin (COHb) values averaged 5-5.5 mg smoke TPM/day/rat and 5.5%, respectively. The pulmonary AHH activity measured at the termination of each experiment showed an average increase of about two- to threefold in smoke-exposed groups. These observations suggested that animals effectively inhaled both gaseous and particulate phase constituents of cigarette smoke. DNAs from nasal, lung, and liver tissue were extracted and analyzed by an improved ^{32}P-postlabeling procedure. The data demonstrate the DNA-damaging potential of long term fresh cigarette smoke exposure and suggest the ability of the tissue to partially recover from such damage following cessation of the exposure.

24756 (PB–90-140831/XAB) **Oral toxicity of 1,2-dichloropropane: Acute, short-term, and long-term studies in rats.** Bruckner, J.V.; MacKenzie, W.F.; Ramanathan, R.; Muralidhara, S.; Kim, H.J. Georgia Univ., Athens, GA (USA). Dept. of Pharmacology and Toxicology. c 1989. 20p. Available from NTIS, PC A03/MF A01.

Pub. in Fundamental and Applied Toxicology, Vol. 12, No. 4, 713-730(1989).

The investigation characterized the acute and short- and long-term toxic potency of orally administered 1,2-dichloropropane (DCP). In the acute and short-term studies, male rats of 250-300 g were gavaged with 0, 100, 250, 500, or 1000 mg DCP/kg in corn oil once daily for up to 10 consecutive days. Although ingestion of DCP caused body weight loss and CNS depression, few other toxic effects were manifest 24 hr after a single dose of the chemical. Morphological changes were limited to liver centrilobular cells in 500 and 1000 mg/kg rats. Similarly, elevated activity of some serum enzymes occurred only at these two highest dose levels. Hepatic nonprotein sulfhydryl (NPS) levels were decreased and renal NPS levels increased at 24 hr. In the short-term study resistance developed to DCP hepatotoxicity over the 10 consecutive days of exposure, as reflected by progressively lower serum enzyme levels and by decreases in the severity and incidence of toxic hepatitis and periportal vacuolization. Nucleolar enlargement in hepatocytes, however, was observed at all dosage levels at 5 and 10 days. There were a number of manifestations of hemolytic anemia, including erythrophagocytosis in the liver, splenic hemosiderosis and hyperplasia of erythropoietic elements of the red pulp, renal tubular cell hemosiderosis, and hyperbilirubinemia.

24757 (PB–90-140849/XAB) **Anaerobic transformation of phenol to benzoate via para-carboxylation: Use of fluorinated analogues to elucidate the mechanism of transformation.** Genthner, B.R.S.; Townsend, G.T.; Chapman, P.J. Technical Resources, Inc., Gulf Breeze, FL (USA). c 1989. 10p. Available from NTIS, PC A02/MF A01.

Pub. in Biochemical and Biophysical Research Communications, Vol. 162, No. 3, 945-951(1989).

Formation of benzoate from phenol and CO2 in sewage sludge when H2 was present was recently reported. While investigating anaerobic degradation of monochlorophenols, the conversion of phenol to benzoate after reductive dechlorination and before mineralization to CO2 and CH4 was observed. Isomeric fluorophenols were used as phenol analogues to investigate the transformation of phenol to benzoate by an anaerobic, phenol-degrading consortium derived from freshwater sediment. Transformation of 2-fluorophenol and 3-fluorophenol occurred in the presence or absence of phenol and led to the accumulation of fluorobenzoic acids. Identification of the resulting fluorobenzoate products as 3-fluorobenzoate and 2-fluorobenzoate isomers, respectively, together with the nontransformation of 4-fluorophenol indicated that the carboxyl group was introduced para to the phenolic hydroxyl group.

24758 (PB–90-142357/XAB) **Health effects assessment for styrene.** Environmental Protection Agency, Cincinnati, OH (USA). Office of Environmental Criteria and Assessment. Aug 1989. 70p. (EPA–600/8-88/054). Available from NTIS, PC A04/MF A01.

The report summarizes and evaluates information relevant to a preliminary interim assessment of adverse health effects associated with specific chemicals or compounds. The Office of Emergency and Remedial Response (Superfund) uses these documents in preparing cost-benefit analyses under Executive Order 12991 for decision-making under CERCLA. All estimates of acceptable intakes and carcinogenic potency presented in the document should be considered as preliminary and reflect limited resources allocated to the project. The intent in the assessments is to suggest acceptable exposure levels whenever sufficient data are available. The interim values presented reflect the relative degree of hazard associated with exposure or risk to the chemical(s) addressed. Whenever possible, two categories of values have been estimated for systemic toxicants (toxicants for which cancer is not the endpoint of concern). The first, RfDS or subchronic reference

dose, is an estimate of an exposure level that would not be expected to cause adverse effects when exposure occurs during a limited time interval. The RfD is an estimate of an exposure level that would not be expected to cause adverse effects when exposure occurs for a significant portion of the lifespan.

24759 (PB–90-142373/XAB) **Updated health effects assessment for acetone.** Environmental Protection Agency, Cincinnati, OH (USA). Office of Environmental Criteria and Assessment. Apr 1988. 32p. (EPA–600/8-89/085). Available from NTIS, PC A03/MF A01.

The report summarizes and evaluates information relevant to a preliminary interim assessment of adverse health effects associated with specific chemicals or compounds. The Office of Emergency and Remedial Response (Superfund) uses these documents in preparing cost-benefit analyses under Executive Order 12991 for decision-making under CERCLA. All estimates of acceptable intakes and carcinogenic potency presented in the document should be considered as preliminary and reflect limited resources allocated to the project. The intent in the assessments is to suggest acceptable exposure levels whenever sufficient data are available. The interim values presented reflect the relative degree of hazard associated with exposure or risk to the chemical(s) addressed. Whenever possible, two categories of values have been estimated for systemic toxicants (toxicants for which cancer is not the endpoint of concern). The first, RfDS or subchronic reference dose, is an estimate of an exposure level that would not be expected to cause adverse effects when exposure occurs during a limited time interval. The RfD is an estimate of an exposure level that would not be expected to cause adverse effects when exposure occurs for a significant portion of the lifespan.

24760 (PB–90-142381/XAB) **Health effects assessment for benzene.** Environmental Protection Agency, Cincinnati, OH (USA). Office of Environmental Criteria and Assessment. Aug 1989. 67p. (EPA–600/8-89/086). Available from NTIS, PC A04/MF A01.

The report summarizes and evaluates information relevant to a preliminary interim assessment of adverse health effects associated with specific chemicals or compounds. The Office of Emergency and Remedial Response (Superfund) uses these documents in preparing cost-benefit analyses under Executive Order 12991 for decision-making under CERCLA. All estimates of acceptable intakes and carcinogenic potency presented in the document should be considered as preliminary and reflect limited resources allocated to the project. The intent in the assessments is to suggest acceptable exposure levels whenever sufficient data are available. The interim values presented reflect the relative degree of hazard associated with exposure or risk to the chemical(s) addressed. Whenever possible, two categories of values have been estimated for systemic toxicants (toxicants for which cancer is not the endpoint of concern). The first, RfDS or subchronic reference dose, is an estimate of an exposure level that would not be expected to cause adverse effects when exposure occurs during a limited time interval. The RfD is an estimate of an exposure level that would not be expected to cause adverse effects when exposure occurs for a significant portion of the lifespan.

24761 (PB–90-142399/XAB) **Health effects assessment for cadmium.** Environmental Protection Agency, Cincinnati, OH (USA). Office of Environmental Criteria and Assessment. Aug 1988. 60p. (EPA–600/8-89/087). Available from NTIS, PC A04/MF A01.

The report summarizes and evaluates information relevant to a preliminary interim assessment of adverse health effects associated with specific chemicals or compounds. The Office of Emergency and Remedial Response (Superfund) uses these documents in preparing cost-benefit analyses under Executive Order 12991 for decision-making under CERCLA. All estimates of acceptable intakes and carcinogenic potency presented in the document should be considered as preliminary and reflect limited resources allocated to the project. The intent in the assessments is to suggest acceptable exposure levels whenever sufficient data are available. The interim values presented reflect the relative degree of hazard associated with exposure or risk to the chemical(s) addressed. Whenever possible, two categories of values have been estimated for systemic toxicants (toxicants for which cancer is not the endpoint of concern). The first, RfDS or subchronic reference dose, is an estimate of an exposure level that would not be expected to cause adverse effects when exposure occurs during a limited time interval. The RfD is an estimate of an exposure level that would not be expected to cause adverse effects when exposure occurs for a significant portion of the lifespan.

24762 (PB–90-142449/XAB) **Health effects assessment for methylene chloride.** Environmental Protection Agency, Cincinnati, OH (USA). Office of Environmental Criteria and Assessment. Aug 1989. 73p. (EPA–600/8-89/092). Available from NTIS, PC A04/MF A01.

The report summarizes and evaluates information relevant to a preliminary interim assessment of adverse health effects associated with specific chemicals or compounds. The Office of Emergency and Remedial Response (Superfund) uses these documents in preparing cost-benefit analyses under Executive Order 12991 for decision-making under CERCLA. All estimates of acceptable intakes and carcinogenic potency presented in the document should be considered as preliminary and reflect limited resources allocated to the project. The intent in the assessments is to suggest acceptable exposure levels whenever sufficient data are available. The interim values presented reflect the relative degree of hazard associated with exposure or risk to the chemical(s) addressed. Whenever possible, two categories of values have been estimated for systemic toxicants (toxicants for which cancer is not the endpoint of concern). The first, RfDS or subchronic reference dose, is an estimate of an exposure level that would not be expected to cause adverse effects when exposure occurs during a limited time interval. The RfD is an estimate of an exposure level that would not be expected to cause adverse effects when exposure occurs for a significant portion of the lifespan.

24763 (PB–90-142464/XAB) **Health effects assessment for naphthalene.** Environmental Protection Agency, Cincinnati, OH (USA). Office of Environmental Criteria and Assessment. May 1988. 35p. (EPA–600/8-89/094). Available from NTIS, PC A03/MF A01.

The report summarizes and evaluates information relevant to a preliminary interim assessment of adverse health effects associated with specific chemicals or compounds. The Office of Emergency and Remedial Response (Superfund) uses these documents in preparing cost-benefit analyses under Executive Order 12991 for decision-making under CERCLA. All estimates of acceptable intakes and carcinogenic potency presented in the document should be considered as preliminary and reflect limited resources allocated to the project. The intent in the assessments is to suggest acceptable exposure levels whenever sufficient data are available. The interim values presented reflect the relative degree of hazard associated with exposure or risk to the chemical(s) addressed. Whenever possible, two categories of values have been estimated for systemic toxicants (toxicants for which cancer is not the endpoint of concern). The first, RfDS or subchronic reference dose, is an estimate of an exposure level that would not be expected to cause adverse effects when exposure occurs during a limited time interval. The RfD is an estimate of an exposure level that would not be expected to cause adverse effects when exposure occurs for a significant portion of the lifespan.

24764 (PB–90-142472/XAB) **Health effects assessment for phenol.** Environmental Protection Agency, Cincinnati, OH (USA). Office of Environmental Criteria and Assessment. Jul 1989. 36p. (EPA–600/8-89/095). Available from NTIS, PC A03/MF A01.

The report summarizes and evaluates information relevant to a preliminary interim assessment of adverse health effects associated with specific chemicals or compounds. The Office of Emergency and Remedial Response (Superfund) uses these documents in preparing cost-benefit analyses under Executive Order 12991 for decision-making under CERCLA. All estimates of acceptable intakes and carcinogenic potency presented in the document should be considered as preliminary and reflect limited resources allocated to the project. The intent in the assessments is to suggest acceptable exposure levels whenever sufficient data are available. The interim values presented reflect the relative degree of hazard associated with exposure or risk to the chemical(s) addressed. Whenever possible, two categories of values have been estimated for systemic toxicants (toxicants for which cancer is not the endpoint of concern). The first, RfDS or subchronic reference

dose, is an estimate of an exposure level that would not be expected to cause adverse effects when exposure occurs during a limited time interval. The RfD is an estimate of an exposure level that would not be expected to cause adverse effects when exposure occurs for a significant portion of the lifespan.

24765 (PB–90-142480/XAB) **Health effects assessment for tetrachloroethylene.** Environmental Protection Agency, Cincinnati, OH (USA). Office of Environmental Criteria and Assessment. Feb 1988. 61p. (EPA–600/8-89/096). Available from NTIS, PC A04/MF A01.

The report summarizes and evaluates information relevant to a preliminary interim assessment of adverse health effects associated with specific chemicals or compounds. The Office of Emergency and Remedial Response (Superfund) uses these documents in preparing cost-benefit analyses under Executive Order 12991 for decision-making under CERCLA. All estimates of acceptable intakes and carcinogenic potency presented in the document should be considered as preliminary and reflect limited resources allocated to the project. The intent in the assessments is to suggest acceptable exposure levels whenever sufficient data are available. The interim values presented reflect the relative degree of hazard associated with exposure or risk to the chemical(s) addressed. Whenever possible, two categories of values have been estimated for systemic toxicants (toxicants for which cancer is not the endpoint of concern). The first, RfDS or subchronic reference dose, is an estimate of an exposure level that would not be expected to cause adverse effects when exposure occurs during a limited time interval. The RfD is an estimate of an exposure level that would not be expected to cause adverse effects when exposure occurs for a significant portion of the lifespan.

24766 (PB–90-142498/XAB) **Health effects assessment for trichloroethylene.** Environmental Protection Agency, Cincinnati, OH (USA). Office of Environmental Criteria and Assessment. Feb 1988. 77p. (EPA–600/8-89/097). Available from NTIS, PC A05/MF A01.

The report summarizes and evaluates information relevant to a preliminary interim assessment of adverse health effects associated with specific chemicals or compounds. The Office of Emergency and Remedial Response (Superfund) uses these documents in preparing cost-benefit analyses under Executive Order 12991 for decision-making under CERCLA. All estimates of acceptable intakes and carcinogenic potency presented in the document should be considered as preliminary and reflect limited resources allocated to the project. The intent in the assessments is to suggest acceptable exposure levels whenever sufficient data are available. The interim values presented reflect the relative degree of hazard associated with exposure or risk to the chemical(s) addressed. Whenever possible, two categories of values have been estimated for systemic toxicants (toxicants for which cancer is not the endpoint of concern). The first, RfDS or subchronic reference dose, is an estimate of an exposure level that would not be expected to cause adverse effects when exposure occurs during a limited time interval. The RfD is an estimate of an exposure level that would not be expected to cause adverse effects when exposure occurs for a significant portion of the lifespan.

24767 (PB–90-142506/XAB) **Health effects assessment for xylenes.** Environmental Protection Agency, Cincinnati, OH (USA). Office of Environmental Criteria and Assessment. Aug 1989. 52p. (EPA–600/8-89/098). Available from NTIS, PC A04/MF A01.

The report summarizes and evaluates information relevant to a preliminary interim assessment of adverse health effects associated with specific chemicals or compounds. The Office of Emergency and Remedial Response (Superfund) uses these documents in preparing cost-benefit analyses under Executive Order 12991 for decision-making under CERCLA. All estimates of acceptable intakes and carcinogenic potency presented in the document should be considered as preliminary and reflect limited resources allocated to the project. The intent in the assessments is to suggest acceptable exposure levels whenever sufficient data are available. The interim values presented reflect the relative degree of hazard associated with exposure or risk to the chemical(s) addressed. Whenever possible, two categories of values have been estimated for systemic toxicants (toxicants for which cancer is not the endpoint of concern). The first, RfDS or subchronic reference dose, is an estimate of an exposure level that would not be expected to cause adverse effects when exposure occurs during a limited time interval. The RfD is an estimate of an exposure level that would not be expected to cause adverse effects when exposure occurs for a significant portion of the lifespan.

24768 (PB–90-142514/XAB) **Health effects assessment for chlorobenzene.** Environmental Protection Agency, Cincinnati, OH (USA). Office of Environmental Criteria and Assessment. Jan 1989. 47p. (EPA–600/8-89/099). Available from NTIS, PC A03/MF A01.

The report summarizes and evaluates information relevant to a preliminary interim assessment of adverse health effects associated with specific chemicals or compounds. The Office of Emergency and Remedial Response (Superfund) uses these documents in preparing cost-benefit analyses under Executive Order 12991 for decision-making under CERCLA. All estimates of acceptable intakes and carcinogenic potency presented in the document should be considered as preliminary and reflect limited resources allocated to the project. The intent in the assessments is to suggest acceptable exposure levels whenever sufficient data are available. The interim values presented reflect the relative degree of hazard associated with exposure or risk to the chemical(s) addressed. Whenever possible, two categories of values have been estimated for systemic toxicants (toxicants for which cancer is not the endpoint of concern). The first, RfDS or subchronic reference dose, is an estimate of an exposure level that would not be expected to cause adverse effects when exposure occurs during a limited time interval. The RfD is an estimate of an exposure level that would not be expected to cause adverse effects when exposure occurs for a significant portion of the lifespan.

24769 (PB–90-142571/XAB) **Current Intelligence Bulletin 51. Carcinogenic effects of exposure to propylene oxide.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 13 Jul 1989. 19p. (DHHS/PUB/NIOSH–89-111). Available from NTIS, PC A03/MF A01.

See also PB–87-202792.

The purpose of the bulletin is to disseminate recent information on the potential carcinogenicity of propylene oxide. Recent studies of the chronic effects of the chemical in animals have produced evidence that cancer is associated with exposure to propylene oxide. The bulletin describes the results of those animal studies, presents the known human health effects of propylene oxide, and suggests guidelines for minimizing occupational exposures.

24770 (PB–90-146069/XAB) **Multiple-site carcinogenicity of benzene in fischer 344 rats and B6C3F1 mice.** Huff, J.E.; Haseman, J.K.; DeMarini, D.M.; Eustis, S.; Maronpot, R.R. Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab. c 1989. 42p. (EPA–600/J-89/224). Available from NTIS, PC A03/MF A01.

Pub. in Environmental Health Perspectives, Vol. 82, 125-163(1989). Portions of this document are not fully legible.

Two-year toxicology and carcinogenesis studies of benzene were conducted in groups of 50 F344/N rats and 50 B6C3F1 mice of each sex and for each of three exposure doses and vehicle controls. These studies were conducted because of large production volume and widespread human exposure to benzene, because of the epidemiologic association with leukemia, and because previous studies were considered inadequate for determining carcinogenicity. Doses of 0, 50, 100 or 200 mg/kg body weight benzene in corn oil (5 ml/kg) were administered by gavage to male rats, 5 days per week for 103 weeks. Doses of 0, 25, 50, or 100 mg/kg benzene in corn oil were administered by gavage to female rats and to male and female mice for 103 weeks. At week 92 for rats and week 91 for mice, survival was greater than 60% in all groups; most of the animals that died before week 103 had neoplasia. Benzene-associated nonneoplastic or neoplastic effects on the hematopoietic system, Zymbal gland, forestomach, and adrenal gland were found for rats and mice.

24771 (PB–90-146127/XAB) **Sensitivity of rat and mouse peripheral blood lymphocytes to Ba adduction and SCE (sister chromatid exchange) formation.** Kligerman, A.D.; Nesnow, S.; Erexson, G.L.; Earley, K.; Gupta, R.C. Environmental Protection

Agency, Research Triangle Park, NC (USA). Health Effects Research Lab. c 1989. 7p. (EPA–600/J-89/218). Available from NTIS, PC A02/MF A01.

Pub. in Carcinogenesis, Vol. 10, No. 6, 1041-1045(1989).

Both mice and rats were injected i.p. with doses of benzo(a)pyrene (B(a)P) ranging from 10 to 100 mg/kg to compare species sensitivity to SCE induction and DNA adduct formation, as well as the relationship between these endpoints. Twenty-four hours after injection, blood was removed by cardiac puncture and the PBLs analyzed for both DNA adduct formation by (32)P-postlabeling and SCE induction following lymphocyte culture. B(a)P induced similar, but not identical, SCE dose-response curves for each species. After B(a)P administration, the major DNA adduct, BPDEI-dGuo, was approximately tenfold more prevalent in the PBLs of the mouse than the rat. If one assumes that BPDEI-dGuo is responsible for the observed SCE induction in each species, then this adduct is a much more efficient SCE inducer in the rat than the mouse. Alternatively, the major adduct may not be causally related to SCE induction. Even though many more adducts are formed in the PBLs of the mouse compared to those of the rat, the rat is the preferred subject for this type of study because of the large amount of blood that can be obtained from each animal as well as the linearity of the dose-response curve for DNA adducts in the PBLs of this species.

24772 (PB–90-146606/XAB) **Volatilization of selenium from astragalus plants irrigated with selenium-laden water. Open file report.** MacDonald, D.J.; Lujan, M.J.; Ary, T.S. Bureau of Mines, Reno, NV (USA). Reno Research Center. 1989. 9p. (BUMINES-OFR–01-90). Available from NTIS, PC A02/MF A01.

Living plants of Astragalus bisulcatus and Atriplex canescens were irrigated with solutions containing selenium to investigate the plants' ability to selectively remove selenium from selenium-contaminated water. The plants were grown from seed in an indoor environment and harvested for analysis at the end of a typical 7-month growing season. Of the total selenium applied to soil in which the plants were grown, only about 1% was incorporated in plant tissues of Astragalus, but approximately 18% of applied selenium was dissipated into the air from the living plants. Atriplex plants did not absorb or dissipate detectable amounts of selenium.

24773 (PB–90-856220/XAB) **Mercury and mercury compounds toxicology. March 1978-July 1989 (Citations from the Life Sciences Collection data base). Report for March 1978-July 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 152p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning the toxic effects of mercury and mercury compounds on biological systems. Mercury metal, mercury vapors, organic mercury compounds, mercury halides, and other inorganic mercury compounds are discussed. Citations include acute, chronic, environmental, metabolic, and pathological effects; and clinical biochemistry of mercury exposure. Heavy metal pollution and bioaccumulation are referenced in related published bibliographies. (Contains 340 citations fully indexed and including a title list.)

24774 (PB–90-856329/XAB) **Polychlorinated biphenyls (PCB's): Toxicity and Metabolism. January 1979-August 1989 (Citations from Pollution Abstracts). Report for January 1979-August 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 137p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning the toxicity and metabolism of polychlorinated biphenyl compounds or PCB's. Environmental, occupational, and health effects of exposure to PCB's, and the mechanisms of uptake and metabolism are discussed for both humans and animals. Clinical aspects of exposure are examined, including poisoning, liver disease, carcinogenesis, neurological disorders, and reproductive effects. PCB's as pollutants and their environmental fate are considered in related published bibliographies. (Contains 303 citations fully indexed and including a title list.)

24775 (PB–90-856436/XAB) **Polychlorinated biphenyls (PCB's) Toxicology. April 1978-July 1989 (Citations from the Life Sciences Collection data base). Report for April 1978-July 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 139p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning the toxicology and metabolism of polychlorinated biphenyls (PCB's). Included are adverse health effects, especially liver and kidney function, neurological disorders, immune response, ecological impacts on animal species, reproductive consequences, poisoning, mutagenicity, carcinogenicity, biological accumulation, and occupational exposure to PCB's. Mechanisms of PCB toxicity are examined for both humans and animals. Metabolism and fate of these compounds is also discussed. The occurrence of PCB's as pollutants, and toxicological studies of polybrominated biphenyl compounds are referenced in related published bibliographies. (Contains 294 citations fully indexed and including a title list.)

24776 (PB–90-856618/XAB) **Dioxins: Toxicity and health risks. January 1979-August 1989 (Citations from Pollution Abstracts). Report for January 1979-August 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 119p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning the toxicology of dioxins and the health risks associated with dioxin exposure. Articles include mortality and physiological studies of major dioxin contamination such Seveso and Love Canal. The biochemistry of dioxin poisoning, environmental impacts, sources of dioxin pollution, metabolism of dioxins by microorganisms, carcinogenicity, occupational exposure, and risk assessment of dioxin exposure by the general public are also discussed. Some mention is made of Agent Orange exposure in the military during the Vietnam War. (Contains 276 citations fully indexed and including a title list.)

24777 (PB–90-856857/XAB) **Formaldehyde: Toxicity and occupational exposure. April 1978-July 1989 (Citations from the Life Sciences Collection data base). Report for April 1978-July 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 88p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning the toxicology of formaldehyde exposure. Articles include studies on formaldehyde exposure through inhalation, ingestion, in water, and by external physical contact. Mutagenic and carcinogenic characteristics of formaldehyde are discussed as well as clinical aspects of exposure. The biochemistry of formaldehyde toxicity is examined for animals and humans. Articles on formaldehyde as an industrial hazard, in building materials, and in fabrics are referenced in related published bibliographies. (Contains 193 citations fully indexed and including a title list.)

24778 **Cadmium inhalation and male reproductive toxicity.** Ragan, H.A. (Battelle Pacific Northwest Laboratories, Richland, WA (USA)); Mast, T.J. *Reviews of Environmental Contamination and Toxicology (USA)*, 114: 1-22 (1990).

Cadmium is a highly toxic element that is cumulative and has a long biological half-life in mammals. The severe toxicity of cadmium in man has been known for more than 100 years. Despite the knowledge that cadmium is toxic, only 20 human cases of poisoning via ingestion were recorded prior to 1941, whereas in the ensuing five-year period more than 680 cases of cadmium poisonings from accidental oral ingestion of this metal were documented. Some of the recorded effects of exposure to cadmium in laboratory animals include renal tubular damage, placental and testicular necrosis, structural and functional liver damage, osteomalacia, testicular tumors, teratogenic malformations, anemia, hypertension, pulmonary edema, chronic pulmonary emphysema, and induced deficiencies of iron, copper, and zinc. Some of these effects have also been observed in human after accidental exposures to cadmium oxide fumes and are characteristic of the syndrome described in Japan as Itai Itai disease in which ingestion of cadmium is the inciting chemical.134 references.

24779 **Ordering of metal-ion toxicities in different species–extrapolation to man.** England, M.W. (Oak Ridge National Lab., TN (USA)); Turner, J.E.; Hingerty, B.E.; Jacobson, K.B. *Health Physics (USA)*, : 115-8; discussion 119 (1989).

Our previous attempts to predict the toxicities of 24 metal ions for a given species, using physicochemical parameters associated

with the ions, are summarized. In our current attempt we have chosen indicators of toxicity for biological systems of increasing levels of complexity–starting with individual biological molecules and ascending to mice as representative of higher-order animals. The numerical values for these indicators have been normalized to a scale of 100 for Mg^{2+} (essentially nontoxic) and 0 for Cd^{2+} (very toxic). To give predicted toxicities to humans, extrapolations across biological species have been made for each of the metal ions considered. The predicted values are then compared with threshold limit values (TLV) from the literature. Both methods for predicting toxicities have their advantages and disadvantages, and both have limited success for metal ions. However, the second approach suggests that the TLV for Cu^{2+} should be lower than that currently recommended.

24780 Predicting the kinetics of chelating agents in man from animal data. Durbin, P.W. (Lawrence Berkeley Lab., CA (USA)); Schmidt, C.T. *Health Physics (USA),* : 165-73; discussion 174 (1989).

Published data were collected on clearance of 82Br, 24Na, inulin, and the ligands CaNa2-EDTA and CaNa3-DTPA from plasma of rats, dogs, and adult men. Data were restructured to a common base and reanalyzed using a two-compartment open-system kinetic model with an outlet from plasma to urinary excretion or from interstitial fluid to deposition in tissues. This was used to obtain transfer rates, distribution volumes, renal clearance, tracer content of interstitial fluid, and cumulative urinary excretion. The validity of the approach was demonstrated by good agreement of the calculated distribution volumes and renal clearances of the selected tracers with published values obtained by other analytical methods. The values of the parameters of the plasma curves and the transfer rates for EDTA and DTPA in the animals were combined with physiological data to evaluate the kinetic parameters of those substances in man. The human kinetic parameters of the ligands predicted from rat or dog data differed, on the average, from the values calculated from human data by +/- 13 and +/- 38%, respectively. The effective concentration of EDTA or DTPA in body fluids from time of injection to complete excretion and the mean concentration for the first 360 min after injection was calculated to be about four times greater in man than in rats and 3.5 times greater than in dogs for equimolar amounts injected. Based on the pharmacokinetics of DTPA, chelation therapy immediately after an actinide accident involving inhalation or extensive skin damage will be more efficient and more effective if a fraction of the standard clinical ZnNa3-DTPA dosage is administered every few hours instead of as a single daily injection.

24781 Gender-dependent problems in toxicity tests with Ceriodaphnia dubia. Haynes, G.J. (Oak Ridge National Laboratory, TN (USA)); Stewart, A.J.; Harvey, B.C. *Bulletin of Environmental Contamination and Toxicology (USA),* 43(2): 271-279 (Aug 1989). DOE Contract AC05-84OR21400.

The 7-d, three-brood Ceriodaphnia chronic toxicity test developed by Mount and Norberg is used to assess biological quality of water and wastewaters. The test is becoming widely accepted because it involves simple procedures, uses easily measurable and biologically meaningful endpoints (survival and fecundity), and uses a microcrustacean known to be relatively sensitive to various toxicants. The test uses individual animals as true replicates, and is relatively powerful statistically. Because male and female Ceriodaphnia neonates cannot be readily distinguished from one another, a 7-d C. dubia test started with neonates produced by females from stressed cultures may include an initially indeterminant number of males. The presence of males (which can be ascertained with certainty only when the test is nearly complete) can affect interpretation of toxicity test results. In this paper the results of toxicity tests of water samples from streams near the Oak Ridge National Laboratory are used to show the extent to which the presence of male C. dubia can confound the interpretation of a 7-d Ceriodaphnia test's fecundity endpoint. The authors also show the results of short-term experiments suggesting that male C. dubia are more sensitive than females to cadmium and phenol, and discuss the statistical and practical implications of the problems caused by the presence of males in chronic toxicity tests with this species.

5604 Other Environmental Pollutant Effects

24782 (AD-A–215340/1/XAB) **Structural alterations in the cornea from exposure to infrared radiation. Final report, 1 April 1986-14 April 1988.** Farrall, R.A.; McCally, R.L.; Bargeron, C.B.; Green, W.R. Johns Hopkins Univ., Laurel, MD (USA). Applied Physics Lab. Aug 1989. 31p. Available from NTIS, PC A03/MF A01.

This report summarizes our research on the interaction of infrared radiation, especially from high-intensity CO_2 TEA lasers, with the cornea. The research reported here was performed between April 1, 1986 and April 14 1988. The report discusses threshold epithelial damage from single- and multiple-pulse exposures, material ejection from the anterior corneal surface, lesion histology, and possible damage mechanisms.

24783 (LA-UR–90-445) **Laser-induced shock waves effects in materials.** Dingus, R.S.; Shafer, B.P. Los Alamos National Lab., NM (USA). [1990]. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900178–1: Biomedical optics '90, Los Angeles, CA (USA), 14-19 Jan 1990). Order Number DE90007626. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A review of the effects of pressure pulses on materials is presented with an orientation toward laser-induced shock wave effects in biological tissue. The behavior is first discussed for small amplitudes, namely sound waves, since many important features in this region are also applicable at large amplitudes. The generation of pressure pulses by lasers is discussed along with amplitudes. The origin and characteristic properties of shock waves are discussed along with the different types of effects they can produce. The hydrodynamic code techniques required for shock wave calculations are discussed along with the necessary empirical data base and methods for generating that data base. 7 refs., 15 figs.

24784 (PB–90-857269/XAB) **Urban noise pollution. November 1981-December 1989 (Citations from the NTIS data base). Report for November 1981-December 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 70p. Available from NTISPC N01/MF N01.

Supersedes PB–87-867099.

This bibliography contains citations concerning aspects of noise in the urban environment. Topics include noise pollution from airports, rail systems, and vehicular traffic. Abatement techniques and community response to urban noise are discussed. (This updated bibliography contains 122 citations, 19 of which are new entries to the previous edition.)

24785 (PB–90-857285/XAB) **Laser radiation: Health hazards and adverse biological effects. June 1975-December 1989 (Citations from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for June 1975-December 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 122p. Available from NTISPC N01/MF N01.

Supersedes PB–88-861596.

This bibliography contains citations concerning human injury thresholds, protective devices, and safety practices involving laser radiation in industrial and military applications. Excluded are references to lasers in surgery or medicine, which are found in other Published Searches. (This updated bibliography contains 234 citations, 69 of which are new entries to the previous edition.)

24786 EMP simulators and public safety: An analysis. Agouridis, D.C. (Oak Ridge National Lab., TN (USA)); Easterly, C.E. *Bioelectromagnetics (New York) (USA),* 10(4): 355-360 (1989).

Effects produced by electromagnetic fields from exoatmospheric nuclear detonations, known as electromagnetic pulses (EMPs) and devices, which simulate these EMPs are analyzed for their potential danger to human beings in contact with large energy collectors. Comparison is made with ANSI guidelines established for radiofrequency electromagnetic fields.

24787 Rats reproduce and rear litters during chronic exposure to 150-kV/m, 60-Hz electric fields. Rommereim, D.N. (Battelle, Pacific Northwest Laboratories, Richland, WA (USA)); Kaune, W.T.; Anderson, L.E.; Sikov, M.R. *Bioelectromagnetics (New York) (USA),* 10(4): 385-389 (1989).

Mature female rats and their subsequent litters were exposed either to 112- or to 150-kV/m, 60-Hz electric fields or sham-exposed for 19 h daily through pre-breeding, breeding, and rearing periods of experimentation. Exposed females mated in equal percentages and reared litters of equal numbers, and mean body masses of pups were the same as those of sham-exposed animals. Thus, experiments to investigate electric-field effects on reproduction and development in rats are feasible at effective field strengths of 112 and 150 kV/m.

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Refer also to citation(s) 23814, 23815

58 GEOSCIENCES

Refer also to citation(s) 23593, 23773, 24035, 24336, 24410, 25210

24788 (BNL–43663) **Shelf Edge Exchange Processes, 2: SEEP2-05, R/V ENDEAVOR cruise 180: Hydrographic data report.** Wilson, C.; Behrens, W.J.; Flagg, C.N.; Wallace, D.W.R.; Wilke, R.J.; Wyman, K.D. Brookhaven National Lab., Upton, NY (USA). Dec 1989. 328p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. Order Number DE90008506. Available from NTIS, PC A14/MF A01 - OSTI; GPO Dep.

The R/V ENDEAVOR cruise 180, SEEP2-05, took place from 23 June–2 July 1988 and deployed ten moorings along two cross-shelf lines (referred to as the North and South lines) across the outer continental shelf. During this cruise 63 CTD casts were made measuring pressure, temperature, conductivity, dissolved oxygen, fluorescence and light transmission. Discrete samples were taken in rosette-mounted Niskin bottles and analyzed for concentration of nutrients, chlorophyll a, dissolved oxygen, and particulate organic carbon and nitrogen.

24789 (DOE/ER/13466–T1) **Organic geochemistry of outer continental margins and deep ocean sediments: Progress report, March 1, 1989–February 28, 1990.** Whelan, J.K. Woods Hole Oceanographic Institution, MA (USA). Dept. of Chemistry. [1990]. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13466. Order Number DE90008649. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This report discusses the activities and progress made in the study of continental margins and deep ocean sediments. Topics discussed are the calibration of thermal maturation markers, hydrous pyrolysis studies and sample collection. (KS)

24790 (DOE/ER/60351–5) **Nearshore transport processes affecting the dilution and fate of energy-related contaminants: Progress report.** Blanton, J.O. Skidaway Inst. of Oceanography, Savannah, GA (USA). 28 Feb 1990. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract FG09-85ER60351. Order Number DE90008840. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The DOE regional coastal oceanographic program in the southeast will be reorganized, and the final year of research supported under this grant will be devoted to synthesizing the results of the most recent experiment on cross-shelf exchange: FLEX. The synthesis of data from this experiment is being complemented by modeling experiments partially supported under this grant and conducted by Francisco Werner (SkIO). The central focus of research supported under this grant is "exchange" processes on the continental shelf with emphasis on the inner 20 km of the shelf. The circulation associated with the coastal frontal zone plays a fundamental role in exchanging water and momentum between the inner shelf (~ 0–20 km) and the middle shelf. The modelling efforts have illuminated the function of wind stress and the pile-up of sealevel along the Florida-Georgia coast in the exchange process. A simple box model has been applied to the inner shelf with encouraging results. All these efforts constitute the principal topics of research over the past year. The synthesis of field and model data has revealed that the currents generated by the very strong winds during FLEX were not as strong as during the earlier period when winds were weaker. We are proposing two possibilities to explain this finding: (1) bottom friction was enhanced by the high gravity waves thus slowing the currents; and (2) the pile-up of sealevel along the Florida coast exerted a northward pressure gradient that essentially opposed the southward wind stress to a small degree. The relative importance of each possibility is the subject of the next year's research.

24791 (DOE/ER/60450–4) **Coordination: Southeast continental shelf studies: Progress report, 1 June 1990–31 May 1991.** Menzel, D.W. Skidaway Inst. of Oceanography, Savannah, GA (USA). 26 Jan 1989. 45p. Sponsored by U.S. DOE Energy Research. DOE Contract FG09-86ER60450. Order Number DE90008835. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Under the terms of grant FG09-86ER6040 the principal investigator, D. Menzel, is responsible for coordinating activities associated with the conduct of research, sponsored by the Department of Energy, on the oceanography of the Southeast Continental Shelf. These activities include: (1) serving as a contact between program managers at DOE and principal investigators associated with the program, (2) developing and implementing long-range research plans, (3) providing DOE with summaries of the results of past and current research, (4) conducting planning/reporting meetings involving principal investigators and interested agency personnel, and (5) consolidating and scheduling the use of research vessels.

24792 (IAEA-TECDOC–502) **Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.** International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. 482p. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

The conference presentations were devoted to the use of isotope techniques in hydrology (34 papers). A separate abstract was prepared for each of these papers. Refs, figs and tabs.

24793 (IAEA-TECDOC–502, pp. 11-32) **Isotopic study of the aquifer in the Tulum and Ullum-Zonda Valleys, San Juan, Argentina.** Albero, M.C. (Instituto de Geocronologia y Geologia Isotopica, Buenos Aires (Argentina)); Levin, M.; Panarello, H.O.; Garcia, E.; Lohn, P. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

An isotopic and hydrochemical study on groundwater from Ullum-Zonda and Tulum Valleys, San Juan province, Argentina, has been performed. Recharge areas and the different water types feeding the basin groundwater were determined. Gross isotopic differences among the San Juan river, originated in the high Cordillera de los Andes ($\delta^{18}O$ = -16 per mille), rainwater over the surrounding hills ($\delta^{18}O$ = -7 per mille) and the more positive local precipitation favoured this characterization. Also ^{14}C content of twelve groundwater samples are presented. The interpretation of these results is discussed. (author). 9 refs, 3 figs, 2 tabs.

24794 (IAEA-TECDOC–502, pp. 33-50) **Isotopic and chemical variations of groundwater in the deep aquifer of the Ombucta Formation, Bahia Blanca, Argentina.** Bonorino, A.G. (Universidad Nacional del Sur, Bahia Blanca (Argentina)); Panerello, H.O.; Albero, M.C. International Atomic Energy Agency,

Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

Stable isotopes and ^{14}C data on Bahia Blanca basin, Ombucta Formation are presented. Previous hydrochemical and geological studies led to the conclusion that Ombucta aquifer is recharged by water rising through fractures and diaclases from underlying paleozoic rocks. This up movement occurs along a section coincident with the regional tectonic alignment that crosses Bahia Blanca city in W-E direction. Water penetrating this formation moves northward and southward with different velocities, as inferred from thermal and hydraulic gradients. ^{14}C isochrones agree with isochloride curves and the correlation between water ages and stable isotopes values suggest colder climatic conditions prevailing when water infiltrated. Meteoric origin of groundwater and catchment area location at Sierras Australes are confirmed by these results. (author). 20 refs, 9 figs, 2 tabs.

24795 (IAEA-TECDOC–502, pp. 51-71) **Isotopic study of the Botucatu aquifer system in the Brazilian portion of the Parana Basin.** Silva, A.A. Kimmelmann e (Sao Paulo Univ., SP (Brazil)); Reboucas, A.C.; Santiago, M.M.F.; Silva, R.B. Gouvea da. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. Contract IAEA-3648;Contract FINEP/PADCT-5384057700. (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

The aim of this study is the application of environmental isotope techniques (^{18}O, ^{2}H, ^{13}C, ^{14}C, ^{3}H) in order to investigate the flow path, the processes controlling the chemical composition, the recharge, as well as, the origin, the apparent ages and the dynamic of the Botucatu Aquifer. In the Brazilian portion of the Parana Basin, where the Botucatu Aquifer was investigated, it covers about 818,000 km^2. This aquifer is confined by basalt flows over 90% and unconfined along the borders of the Basin. The aquifer is constituted by Mesozoic, eolic and fluvial sandstones with thicknesses 1,000 m. The hydrochemical and isotope data of about 40 sampled wells permit the following conclusions: (1) The recharge is mainly due to the infiltration of precipitations. (2) The variation of the stable isotope content: $\delta^{18}O$ from -4.9 to -9.8 per mille, $\delta^{2}H$ from -28 to -67.0 per mille and $\delta^{13}C$ from -5.9 to -23.7 per mille in the groundwater indicates possible climatic changes during the different recharge periods. (3) The trend of a gradual increase of temperature from 17.5 to 48 deg. C, pH from 5.36 to 9.62, total dissolved solids from 36.87 to 504.03 mg/1, as well as, average apparent ages from 480 to 38,825 years is from the outcrop area towards the central part of the Basin, following the progressive confining conditions of the aquifer. (4) The calcium and/or mixed bicarbonate water type on the borders of the Basin changes to sodium bicarbonate towards its central part. (author). 16 refs, 6 figs, 3 tabs.

24796 (IAEA-TECDOC–502, pp. 73-89) **Isotope study of wells in crystalline rock of the semi-arid northeast of Brazil.** Frischkorn, H. (Ceara Univ., Fortaleza (Brazil). Dept. of Hydraulics); Santiago, M.F.; Serejo, A.N. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

During a drought of five years, ending in 1984, a series of wells situated around Araras Dam, in the hydrographic basin of Acarau River, in Ceara State, in the semiarid Northeast of Brazil, was studied using environmental isotope methods (^{14}C, ^{3}H, $^{18}O/^{16}O$) and chemical analysis. Twenty samples gave ^{14}C concentrations higher than 97.6% modern (conventional age shorter than 200 years) and are interpreted in terms of an exponential model giving residence times of some decades. These values were confirmed by tritium measurements. Seven samples exhibit ages between 200 and 500 years and only two have more than 1000 years. $^{18}O/^{16}O$ measurements gave values close to rainwater and prove that the aquifer is recharged by direct surface runoff. Even a slight continental effect can be detected in the wells. The isotope ratio in the wells is found to be independent from that of Araras Dam. (author). 9 refs, 6 figs, 7 tabs.

24797 (IAEA-TECDOC–502, pp. 91-101) **The use of oxygen isotopic composition to study water dynamics in Amazon floodplain lakes.** Martinelli, L.A. (Centro de Energia Nuclear na Agricultura, Piracicaba, SP (Brazil)); Mortatti, J.; Victoria, R.L.; Richey, J.E.; Forsberg, B.R.; Matsui, E. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

The lakes formed in the Amazon floodplain play a key role in sustaining the highest populational density in the Amazon Basin because of its high primary productivity. The water volume in these lakes vary greatly during the year and possible water sources are the feeding river during high water state of the hydrographs and local inputs from its drainage basin. As these sources are chemically distinct, to understand the nutrient dynamics in these lakes, it is very important to know the relative water contribution of different water sources. In this paper we use ^{18}O as a conservative to know the water sources for the lakes and our hypothesis is that: (1) In the high water stage lake water is derived predominantly from its feeding river. Therefore their $\delta^{18}O$ should be similar. (2) In the low water stage lake water is a mixture of watershed and last flood event waters. In this case, lake $\delta^{18}O$ should be indicative of the relative contribution of each source. To test this hypothesis we assume a two end member mixing a model. If the ^{18}O isotopic composition of these two sources are known the relative contribution of each source may be calculated by isotopic dilution equation. The first step in this work was to know the ^{18}O isotopic composition of the lakes and feeding rivers and its spatial and temporal variability. Clearly the $\delta^{18}O$ signal in the lakes of Amazon varzea is controlled by the ^{18}O content of the feeding river. But there is a consistent pattern in the ^{18}O enrichment of the lakes versus the feeding rivers, which is most pronounced on low water period. Our initial hypothesis requires that this water be of local drainage basin origin. Although it was not possible to measure the isotopic composition of local drainage water, indirect measurement suggest that this could be the case. (author). 17 refs, 4 figs, 2 tabs.

24798 (IAEA-TECDOC–502, pp. 113-127) **Isotope hydrology investigation, area of the Salar de Llamara, Atacama Desert, Chile.** Pena, H. (Ministerio de Obras Publicas, Santiago (Chile). Direccion General de Aguas); Grilli, A.; Salazar, C.; Orphanopoulos, D.; Suzuki, O.; Aravena, R.; Rauert, W. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France);

Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

Different applications of environmental isotopes (^{18}O and ^{2}H) in relation with the hydrogeology of a Northern Chilean basin are presented. The investigation was centered specially in the isotopic characterization of springs and rivers, evaporation processes in river, the generation of the floods, infiltration processes in the alluvium fans, and the origin and movement of the groundwater. (author). 5 refs, 12 figs.

24799 (IAEA-TECDOC–502, pp. 191-202) **Groundwater study in the semi-arid area of Atlantico-Bolivar (Colombia).** Sanchez, L. (Instituto de Asuntos Nucleares, Bogota (Colombia)); Obando, E.; Jimenez, G.; Torres, E.; Alayon, E.; Huget, A.; Mosquera, F.; Vargas, M.C.; Stichler, W. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

The hydrogeology of the zone called Atlantico-Bolivar was investigated with isotope and chemical techniques. The zone is located in northern Colombia and has a surface area of 5,570 km^2. It can be subdivided into four areas: western mountain area, hilly area, low marshy land and zone flooded by the Magdalena River. More than 200 water samples from wells, marshes, rivers and rains have been analysed during four years. The chemical analysis of water has brought identification of areas with different compositions. By means of stable isotopes it was possible to identify that: (i) some wells are recharged by the Magdalena River; (ii) there is no recharge deriving from marshes in deep wells; (iii) the artesian wells are recharged by local precipitation; (iv) in some wells the water may partially derive from the deep Tertiary aquifer. Finally, the tritium content indicates that groundwater is always older than 1954, with the exception of that deriving from the Magdalena River. (author). 4 refs, 10 figs.

24800 (IAEA-TECDOC–502, pp. 203-213) **Evaluation of the Sabana de Bogota aquifer using isotope techniques.** Torres, E. (Instituto de Asuntos Nucleares, Bogota (Colombia)); Jimenez, G.; Obando, E.; Alayon, E.; Sanchez, L. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

We studied the Sabana de Bogota aquifer by using isotopic techniques, such as stable isotopes (deuterium, oxygen-18), tritium, carbon-14, and injected radiotracers to determine the horizontal velocity of groundwater and aquifer parameters (by injecting the tracer in a piezometer and monitoring it in a nearby exploitation well). With these techniques and the hydrogeological information provided by Ingeominas, it was possible to determine origin of recharge, equipotential lines and direction of groundwater. (author). 4 refs, 8 figs.

24801 (IAEA-TECDOC–502, pp. 215-228) **Investigation of a volcanic aquifer system in Costa Rica using environmental isotopes.** Darling, W.G. (Hydrogeology Research Group, Wallingford (UK). British Geological Survey); Parker, J.M.; Rodriguez, H.V.; Lardner, A.J. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

A series of aquifers formed from volcanic rocks occurs in the Valle Central of Costa Rica. Lavas mainly from the Barba volcano are interbedded with pyroclastics, resulting in an aquifer system complex both vertically and laterally. Environmental isotopes have been used as part of a wider hydrogeological study of the Valle Central. The tritium contents of discharge from the various lava groups have been measured to assess groundwater residence times. Stable isotope analyses of borehole, spring and river samples collected over a period of several years have helped to clarify the recharge regime which is primarily one of downward transfer between lava layers. The general trend is one of heavy isotope enrichment with increasing depth, suggesting that the lower aquifers receive an input of water additional to large amounts of downward leakage. Most of this water is assumed to be lower altitude rainfall, but there is some evidence that the normal isotope-altitude relationship may not apply in the Valle Central. Although most of the aquifers considered have a relatively homogeneous isotopic composition, the deepest aquifer of the series has a bimodal distribution of values. This has provided additional information on sources of recharge to this aquifer. (author). 12 refs, 6 figs, 2 tabs.

24802 (IAEA-TECDOC–502, pp. 229-243) **Isotopic study of the southern plain in the Pinar del Rio province, Cuba.** Arellano, D.M. (Instituto de Hidroeconomia, La Habana (Cuba)); Feitoo, R.; Seiler, K.P.; Stichler, W.; Rauert, W. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

The approx. 4600 km^2 area under study is a part of the southern plain of the most western province (Pinar del Rio) of the Republic of Cuba. The Miocene plain aquifer is a typical karstic plain one underlying 20-80 m-thick Quaternary alluvial and post-alluvial deposits except in in the most western part where unconfined aquifer conditions occur in some places. Taking into account the low permeability of the pre-mountainous zone, any interrelation with water from mountainous karst zone running to the pre-mountainous area and recharging the plain aquifer has not been found yet. In order to determine the conditions under which a natural groundwater recharge to the aquifer occurs, rainfall isotope composition measurements were made in four specific raingauge stations, in springs located in mountainous zones and in plain water wells at different depths. The ^{3}H concentrations together with the stable isotope composition were determined. The isotope composition variability assumes the occurrence of an interrelation among mountainous, pre-mountainous and plain zones, so that the breaking-caused permeability in the pre-mountainous rock subsurface layer as well as the possible contribution of rivers to the groundwater flow circulation are evident. (author). 7 refs, 11 figs, 1 tab.

24803 (IAEA-TECDOC–502, pp. 245-258) **Study with environmental isotopes of the origin of groundwater and salt**

Intrusion in the central part of the southern Matanzas Valley, Cuba. Gonzalez Baez, A. (Instituto de Hidroeconomia, La Habana (Cuba)); Seiler, K.P.; Stichler, W.; Rauert, W. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

In the Matanzas area, groundwater is used more for pressure irrigation than for water supply purposes. On zones where a serious non-confined and kastified aquifer groundwater withdrawal occurs, sodium and chloride content increases are observed, affecting both irrigation utilities from the chloride point of view and from soil salinity. Relating to chloride origins, four possibilities are considered: a contribution of water evaporated from Zapata's Swamp; a sea water intrusion; a connate water intrusion; a loam-fixed chloride and sodium dissolution. Based on hydrochemical and isotope assessments an origin of water salinization from Zapata's Swamp is excluded. Referring to the other three chloride origins, a sea water intrusion is not completely proved, and for a salt water intrusion or chloride dissolutions a sufficient sampling is not available. From an isotope point of view the karst aquifer does not contain old waters; water recharge is made more or less within the last 30 years i.e., the stratification of fresh water and transition zone ages, according to research made up to now. Moreover, flow field seems very heterogeneous with a high variation of stable isotope content. Carbon-14 values are grouped about an average of 80 p.m.c. (author). 14 refs, 8 figs, 1 tab.

24804 (IAEA-TECDOC–502, pp. 259-271) **Isotopic measurement interpretation in the Rio Sonador springs and the Rio Aguacate spring, in the north of the Dominican Republic.** Febrillet, J.F. (Instituto Nacional de Recursos Hidraulicos, Santo Domingo (Dominican Republic)); Bueno, E.; Seiler, K.P.; Stichler, W. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

Isolated karstified limestone blocks in a clay formation are found in the Yasica River valley. A small amount of groundwater is stored in clay and runoff is high. On the contrary, the infiltration in limestone amounts approximately to 48 1/s-km^2 or 1510 mm/a, which is the difference between precipitation (2110 mm/a) and evaporation (605 mm/a). Groundwater flows from springs at the basis of the limestone blocks. The main objective of this investigation is the determination of the discharge stability of Sonador River, for hydroelectrical purposes. The isotopic and conventional investigations show that the mean residence time of groundwater is about one year. As a consequence, the discharge of springs feeding the Sonador River does not decrease in a short time after the rainy period, because the aquifer has good storing capacity and large recharge. The spring discharge decreases to values of 0.6 m^3/s in 140 days and 0.3 m^3/s in 310 days of drought. The minimum discharge of Sonador River was 0.5 m^3/s during 11 years of monitoring. (author). 5 figs, 2 tabs.

24805 (IAEA-TECDOC–502, pp. 273-289) **Isotopic and hydrogeological investigations in the southwest region of the Dominican Republic.** Febrillet, J.F. (Instituto Nacional de Recursos Hidraulicos, Santo Domingo (Dominican Republic)); Bueno, E.; Seiler, K.P.; Stichler, W. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

The southwestern part of the Dominican Republic is quite poorly developed. Two mountain ranges, that are strongly folded and faulted cross this area with the Lago Enriquillo in between, whose water level is below sea level. In the low lands evapotranspiration exceeds precipitation and vice versa in the high lands rising up to 2367 m.a.s.l. Water balance shows groundwater recharge of 181 a 227 mm/a in the catchment area of the Lago Enriquillo. With the aid of stable isotopes the mean altitude of groundwater recharge was determined to be in the range of 1000 and 2000 m.a.s.l. High altitudes contribute more to the catchment area of the Lago Enriquillo than to the neighbouring areas like the coastal area of the Sierra de Bahoruco and its southern foreland. Considering the regional distribution of stable isotopes in groundwater and determining its mean residence time by means of stable isotopes variations, the content of radioactive environmental isotopes and an analysis of recession flow in dry times leads to the result that discharge is quicker in longitudinal than in transverse direction of the mountain ranges. This is due to tectonic dilatation and compression in the respective directions. The aquifer seems to be subdivided in three floors with an increase of storage capacity with depth. On a large scale each floor has a more or less homogeneous groundwater flow field. The development of artificial recharge is mainly bound to the lowest floor along the low lands of the mountain ranges. From isotope results and hydrogeologic investigations there are five areas in the catchment area of the Lago Enriquillo for future exploitation. In the catchment areas neighbouring the Lago Enriquillo this seems to be problematic. (author). 5 refs, 14 figs, 1 tab.

24806 (IAEA-TECDOC–502, pp. 291-303) **Geothermic model determination in the Chillos Valley (Ecuador) with environmental isotopes.** Changkuon, L. (Comision Ecuatoriana de Energia Atomica, Quito (Ecuador)); Oleas, M.; Aranyossy, J.F.; Lopoukine, M. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

The Chillos Valley (2400 m.a.s.l.) is located at about 20 km southeast of Quito in a tectonic depression filled with alluvial and volcanic sediments. The post-volcanic activity is characterised by the presence of many thermal springs and hot wells around the old volcano Ilalo. In parallel with the hydrogeochemical study of the thermal springs, the environmental isotopic composition (O-18, H-2, H-3, C-13, C-14) has been determined on spring-waters, wells and rivers in the region in order to identify the origin of the hot groundwater, estimate its temperature and localize the heat source. Two main groups of water have been identified: Group 1: Deriving from local recharge by direct infiltration of the rainwater, which has an O-18 content between -11 and -12.5 per mille/SMOW according to the recharge altitude on the Ilalo volcano flank; Group 2: Deriving from regional circulation coming from the high mountains in the south-southeast with more depleted values in stable isotopes (O-18 < -12.5 per mille/SMOW). In view of the isotopic results, the hypothesis of a regional circulation of hot water coming from the east, where hot springs reach more than 50 deg. C, has been discarded. The following hydrothermal circulation scheme is proposed: The

deep water coming from the south-southeast (Group 2), is heated up by a heat source located at the southwest flank of the volcano Ilalo. This water then rises to the surface through tectonic fractures and mixes with water of local origin (Group 1). The proportion of mixing controls the final temperature and isotopic content. As a result of this study, it has been considered useful to drill a deep well in the above geothermal area. (author). 5 refs, 7 figs, 3 tabs.

24807 (IAEA-TECDOC–502, pp. 305-317) **Quito Valley: General behaviour and problems of natural aquifer recharge.** Aranyossy, J.F. (International Atomic Energy Agency, Vienna (Austria)); Pourrut, P.; Maldonado, A. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

The environmental isotopic study of the Quito aquifer system, performed to complement the conventional hydrogeological survey, led us to the identification of two different recharge processes: (1) In the north, the water circulation is of "hypodermic" type on the flank of the volcano Pichincha and the recharge of the aquifer is mainly due to direct infiltration of rainwater and surface water; (2) In the south, the infiltration is more effective in the highest part of the mountain and the aquifer recharge derives from deep groundwater circulation. (author). 5 refs, 6 figs, 2 tabs.

24808 (IAEA-TECDOC–502, pp. 319-335) **Hydrogeological and isotopic investigations of the Lake Peten Itza system in northern Guatemala.** Velasquez, E. (Instituto Nacional de Sismologia, Vulcanologia, Meteorologia e Hidrologia, Guatemala City (Guatemala)); Aragon, V.R.; Seiler, K.P.; Stichler, W. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

The Peten Itza lake inundates and has for the past 8 years damaged many villages bordering the lake. Such inundations have also been known in the past and last, as a rule, for many years. For a better insight into these phenomena, conventional and environmental isotopic investigations were carried out to get a better knowledge of how this lake is linked to the regional hydrologic system. The results of both methods show that the lake is linked to a groundwater system; recharge takes place in the southern area and underground discharge takes place about 45 km. northwest of the lake. From a hydrological point of view, the southern zone belongs to an open karst, strongly karstified, and the northern zone to a confined karst, which is weakly karstified. Permeability of both karst zones was determined by means of both conventional and isotopic methods to be about 1 m/a, and apparent flow velocities in the area of confined karsts are about 5 m/a. By means of isotopic methods the relative contribution of the lake to the discharge area has been determined, showing a long, mean residence time along its underground flow path. As a result the lake Peten Itza is concluded to be a storage reservoir with strong groundwater contributions and weak groundwater losses. (author). 4 refs, 8 figs.

24809 (IAEA-TECDOC–502, pp. 337-353) **Isotopic study of the groundwater of the flatland of Cul-de-Sac, Republic of Haiti.** Gonfiantini, R. (International Atomic Energy Agency, Vienna (Austria)); Simonot, M. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In French). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

The main aquifer of the flatland of the Cul-de-Sac is made up of a multiple alluvial formation which has accumulated in the quaternary on the graben between two anticlinorius of karstified limestone of the eocenic age. The environmental isotopes clearly show the origin and the preferential course of water circulation in the aquifer and its relation with the karstic system. The main source of recharge is the river Gris. The contribution of the north karst is of little importance. The origin of the salinity of the groundwater in the septentrional region of the flatland and the region of Port-au-Prince has also been investigated. The salt water is slightly enriched with heavy isotopes with respect to fresh groundwater, not showing any deviation from the straight line of meteoric waters. These waters could be derived from superficial waters put under evaporation under the condition of relative high humidity or from precipitations of another period which have been enriched with heavy isotopes with respect to the current precipitations. In the area of Port-au-Prince the salinity of the groundwater is the result of seawater intrusion as a consequence of intensive exploitation. 7 refs, 7 figs, 6 tabs.

24810 (IAEA-TECDOC–502, pp. 365-377) **Environmental isotopic study of groundwater in the sub-basin of Yautepec and Cuautla, State of Morelos, Mexico.** Vazquez, S.E. (Universidad Nacional Autonoma de Mexico, Mexico City (Mexico). Inst. de Geofisica); Cortes, S.A.; Jaimes, P.R.; Fritz, P. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

The chemical and isotopic compositions of groundwaters in the sub-basins of Yautepec and Cuautla are described. The isotopic composition of the different groundwaters is very similar (average δD = -72 per mille SMOW and $\delta^{18}O$ = -10.2 per mille SMOW) and in conjunction with the chemical trends suggests that the discharge from a confined lower limestone aquifer, is mixed with water from an upper aquifer. The $\delta^{34}S$ values (5.9 to 10 per mille CDT) and $\delta^{18}O$ values (2.4 per mille SMOW) of the aqueous sulphate of the upper aquifer, reveal a volcanic origin and confirm that the Chichinautzin range and volcano Popocatepetl are recharge zones. In contrast the sulphate in the lower carbonate aquifer ($\delta^{34}S$ = 15.4 to 16.8 per mille CDT and $\delta^{18}O$ = 14.7 to 19.5 per mille SMOW) has an evaporitic origin, and therefore, is interpreted as resulting from deep circulation through Cretaceous anhydrites. The tritium and ^{13}C data as well as the corrected ^{14}C data for the dissolved inorganic carbon, reveal modern recharge waters (<40 years since infiltration) for the upper aquifer, whilst the water of the carbonate aquifer contains components of modern and paleowaters (7000 to 14,000 years). The data suggest that locally mixing of the two systems occurs but document also the existence of a regional flow system with a possible origin in the Sierra Madre Oriental. (author). 15 refs, 7 figs, 2 tabs.

24811 (IAEA-TECDOC–502, pp. 379-398) **Environmental isotopes and geochemical investigation of groundwater in the north-western part of the State of Morelos, Mexico.** Morales, P. (Universidad Nacional Autonoma de Mexico, Mexico City (Mexico). Inst. de Fisica); Casar, I.; Cortes, A.; Arizabalo, R.D.; Aravena, R.

International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

Isotope techniques were used to define the recharge mechanism and origin of the groundwater of the Cuernavaca Valley located in the north-west part of the State of Morelos in Mexico. The groundwater of the valley is contained in two different types of aquifers: one basaltic and the other granular. Statistic analysis of the isotopic data show that the water from both aquifers belong to the same population, probably due to a common origin. The isotopic results (δD = -77 per mille and δ^{18}O = -11 per mille) indicate that the main source of recharge is the infiltration in the high basaltic parts (2600 to 3500 m.a.s.l.) of the Sierra Chichinautzin. The basaltic aquifer due to its high fractured system and low capacity of storage transfer the water to the granular aquifer. The regional groundwater flow in the valley runs from north to south with increasing contribution of local precipitation and evaporated waters from irrigation as it moves south. Tritium contents in the groundwater of all the area indicate recent infiltration and recharge. This study provides useful information for a better evaluation of the groundwater resources available for actual and future urban development of the valley. (author). 16 refs, 9 figs, 2 tabs.

24812 (IAEA-TECDOC–502, pp. 399-412) **Geochemical and isotopic features of groundwater in the Villa Ahumada-Samalayuca region, state of Chihuahua, Mexico.** Villegas, R.F. (Comision Federal de Electricidad, Mexico City (Mexico)); Flores, S.A.; Morales, P. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

The Villa Ahumada - Samalayuca region is located in the Basins and Ranges Province of the Chihuahua State, Mexico, Its climate is arid and semidesertic, with a mean annual precipitation of 258 mm. The geology is characterized by the presence of sandstones, shales and limestones, from Cretassic-Jurassic; there exists a composition of gravel, sand, silt, clay and gypsum, from Terciary-Quaternary. The major ionic chemical data indicate that the groundwater flow, in the region, is S-NW direction; the content of stable isotopes from the shallow and deep groundwater is homogeneous, which supports the existence of one aquifer system, with a recharge from a common origin. 17 refs, 7 figs, 2 tabs.

24813 (IAEA-TECDOC–502, pp. 413-426) **Behaviour of the groundwater system in the Santa Caterina area, Mexico City.** Arizabalo, R.D. (Universidad Nacional Autonoma de Mexico, Mexico City (Mexico). Inst. de Geofisica); Rodriguez, R.; Cortes, A.; Fritz, P. International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

In the southeast area of Mexico City a line of 14 wells exist and are used as a potable water supply for surrounding towns. The average distance between each well is approximately 400 m. Each well was drilled to an approximate depth of 400 m. The results of vertical electrical soundings, performed as part of another study, indicated the presence of mineralized water down to a depth of approximately 200 m with potable water beneath. The granular aquifer is bounded by basaltic flows related to the Sierras de Santa Catarina in the north and the Chichinautzin in the south. To aid in the determination of the age and origin of the different groundwaters indicated by the geophysics, a geochemical and isotopic monitoring program was completed. Geochemical analysis was limited to the major ions. Isotopic analysis included ^{18}O, ^{2}H, ^{3}H, ^{34}S and ^{14}C. Geochemical and isotopic data was significantly varied within the well field. The geochemical, isotopic and geophysical data was combined to produce a hydrogeological and hydrogeochemical qualitative model for the aquifer that exists around the Santa Catarina well field. (author). 11 refs, 3 figs, 7 tabs.

24814 (IAEA-TECDOC–502, pp. 445-450) **Determination of the hydrodynamical dispersion in three aquifers.** Delcore, M.R. (Michigan State Univ., East Lansing, MI (USA). Dept. of Geological Sciences). International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

This paper describes three relatively long lived (31 years) natural tracing experiments which suggest that for short travel distances (< 35 m) dispersivity values are in fact lower than expected based on the type of aquifer material. Naturally occurring bomb tritium was used to trace the vertical movement of recharging groundwater in 3 areas. The interphase between groundwater containing bomb tritium and groundwater containing no bomb tritium was used as an index of the amount of dispersion which has taken place after 31 years of groundwater flow. (author). 5 refs, 1 fig.

24815 (IAEA-TECDOC–502, pp. 451-456) **Determination of the mean annual recharge on the basis of thermonuclear tritium depth in the saturated zone.** Delcore, M.R. (Michigan State Univ., East Lansing, MI (USA). Dept. of Geological Sciences). International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de Investigaciones Nucleares, Mexico City (Mexico). May 1989. (In Spanish). (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

The maximum depth of bomb tritium penetration into the saturated zone at groundwater divides was used with porosity data to calculate the rate of groundwater recharge to three unconfined aquifers. In all three cases the rates of groundwater recharge determined from the depth of bomb tritium penetration are in good agreement with rates previously determined by conventional water budget techniques. (author). 7 refs, 4 figs.

24816 (IAEA-TECDOC–502, pp. 457-462) **Environmental isotope techniques for studying infiltration from rivers to groundwater.** Payne, B.R. (International Atomic Energy Agency, Vienna (Austria)). International Atomic Energy Agency, Vienna (Austria); United Nations Educational, Scientific and Cultural Organization (UNESCO), 75 - Paris (France); Instituto Nacional de

Investigaciones Nucleares, Mexico City (Mexico). May 1989. (CONF-870928–: Seminar for Latin America on the application of isotope techniques in hydrology, Mexico City (Mexico), 28 Sep - 2 oct 1987). In *Isotope hydrology investigations in Latin America: Proceedings of a regional seminar for Latin America on the use of isotope techniques in hydrology held at the Nuclear Investigations Centre of Salazar, Mexico, 28 September - 2 October 1987.* Order Number DE90621477. Available from NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS.

The hydrological significance of the infiltration of surface water to groundwater is discussed, particularly in relation to the extent of mass transport of water. The basic principles of the use of environmental isotope techniques to this type of study are reviewed. A re-evaluation of a study in the Mexicali Valley is presented to illustrate the application. The revised evaluation indicates that groundwater is recharged by water infiltrating from the Colorado and Gila rivers and return irrigation water from the irrigation district Wellton Mohawk. (author). 4 refs, 4 figs.

24817 (PB–90-858069/XAB) **Fractured rock hydrogeology: Modeling studies. January 1977-December 1989 (Citations from the Selected Water Resources Abstracts data base). Report for January 1977-December 1989.** National Technical Information Service, Springfield, VA (USA). Jan 1990. 103p. Available from NTISPC N01/MF N01.

Supersedes PB–89-858138.

This bibliography contains citations concerning the use of mathematical and conceptual models in describing the hydraulic parameters of fluid flow in fractured media. Topics include the use of tracers, solute and mass transport studies, and slug test analyses. The use of modeling techniques in injection well performance prediction is also discussed. (This updated bibliography contains 160 citations, 43 of which are new entries to the previous edition.)

24818 (UCRL–21274) **Damage characteristics of time domain histories.** Thomas, J. California Univ., Irvine, CA (USA). Dept. of Civil Engineering. Nov 1989. 71p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008787. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

It is possible to create nomographs similar to Fig. 2.10 to characterise damage potential of candidate time histories, provided there exists extensive records of earlier time-histories and the damage that they have caused. Thus in order to create such nomographs, one needs the correlated documentation between the input to the structure and the resulting damage. In order to use the Response-Spectra approach, one needs good statistical description of the input to the system. Extensive literature exists on both these methods. The MAC method that has being developed for the present research has yet to be validated. However, if it is successful, it would provide a valuable link between the SEA method and the rational method.

24819 (UCRL–102729) **Waves in partially saturated porous media.** Berryman, J.G. Lawrence Livermore National Lab., CA (USA). Jan 1990. 35p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-8909313–1: SIAM conference on mathematical and computational issues in geophysical fluid and solid mechanics, Houston, TX (USA), 25-29 Sep 1989). Order Number DE90008540. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We summarize efforts to extend the theory of poroelasticity to semilinear and nonlinear elastic response, to partially saturated pores, to inhomogeneous solid frame materials, and to viscous losses due to localized flow effects. The prospects for a comprehensive theory of wave propagation in partially saturated porous media are also discussed. 64 refs., 2 figs.

24820 Geochronology of blueschists from west-central Baja California and the timing of uplift in subduction complexes. Baldwin, S.L. (Dept. of Geol. Sciences, Albany, NY (USA)); Harrison, T.M. *Journal of Geology (USA),* 97(2): 149-163 (Mar 1989).

A geochronologic study of blueschists from west-central Baja California has provided constraints on the timing of high-pressure, low-temperature metamorphism and the subsequent uplift of this subduction complex. Mineral separates from coherent blueschists and blueschist blocks enclosed in serpentinite melange were analyzed by $^{40}Ar/^{39}Ar$, fission track, and Rb/Sr methods. $^{40}Ar/^{39}Ar$ age spectra for white mica separated from four blueschist blocks and an overprinted eclogite block in serpentinite-matrix melange show slow cooling gradients between 115-95 Ma. Rb/Sr apparent ages for one block are concordant with these results. $^{40}Ar/^{39}Ar$ ages of blue amphibole are primarily the result of the degassing of white mica intergrowths as confirmed by microprobe analyses. Apatite fission track ages indicate a blueschist block and an eclogite block cooled to a temperature below ~100 C at 22 Ma and 32 Ma, respectively. Subduction-related metamorphism of the coherent blueschists occurred in late Early Cretaceous time, based on a $^{40}Ar/^{39}Ar$ age or 109 Ma for metamorphic white mica from a metasandstone. $^{40}Ar/^{39}Ar$ analysis of partially albitized K-feldspar from a plutonic clast in a metaconglomerate indicates this sample cooled to a temperature of ~ 145 C at approximately 20 Ma. Geochronologic and petrologic data for coherent blueschists indicate an average uplift rate of 0.1 mm/yr for one portion of the subduction complex. The relatively slow uplift rate and lack of any higher temperature overprinting assemblages in the coherent blueschists suggest that synsubduction uplift was gradual and proceeded through a dynamic accretionary wedge characterized by low geothermal gradients. An increase in uplift rate (to 1.0 mm/yr) during post-Miocene time coincides with a change from a convergent to a transform plate boundary.

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Refer also to citation(s) 23831

24821 (JINR-E–2-88-792) **New putting-onto-mass-shell algorithm.** Shmakov, S.Yu.; Slavin, N.V.; Uzhinskij, V.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation. 1988. 3p. Order Number DE90622139. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

An algorithm is suggested for taking into account binding energy, Fermi-motion of constituents, various elements of the Fock column, etc., in the course of simulation of the bounded system interactions. The algorithm possesses partial relativistic invariance. 1 ref.

6401 Astrophysics and Cosmology

Refer also to citation(s) 24890, 24907, 24978, 25063

24822 (JINR-R–2-88-773) **Gravitational collapse, Friedman models and cosmological constant. Does the universe oscillate.** Bonch-Osmolovskij, A.G. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 10p. (In Russian). Order Number DE90620792. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to Class. Quantum Gravity.

The equivalency of the Tolman-Oppenheimer and Friedman methods is discussed. The solution of Oppenheimer and Snyder describes the Friedman flat Universe in a cosmological aspect. On the other hand, the Friedman results contain the description of gravitational collapse in the accompanying reference frame. It should be noted that the collapse and expansion of matter are phenomena connected indissolubly. The analysis of the cosmological consequences $\Lambda \neq 0$ and the classification of homogeneous and isotropic Universe models is made. Using the obtained results, the hypothesis of a cyclic character of the Universe development is expressed. 7 refs.; 1 tab.

24823 (LA-UR–90-870) **Model atmospheres for novae during the early stages.** Wehrse, R. (Heidelberg Univ. (Germany, F.R.). Inst. fuer Theoretische Astrophysik); Hauschildt, P.H.; Shaviv, G.; Starrfield, S. Los Alamos National Lab., NM (USA). [1989]. 14p. Sponsored by U.S. DOE Management & Administration; National Aeronautics and Space Administration; National Science Foundation. DOE Contract W-7405-ENG-36. Contract AST85-16173;Contract AST88-18215;Contract NAG5-481;Cont (CONF-8906225–3: Physics of classical novae: IAU colloquium no. 122, Madrid (Spain), 27-30 Jun 1989). Order Number DE90008938. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Continuum and line blanketing models for the photospheres of novae in the early stages of their outbursts are presented. The expanding envelopes are characterized by a very slow increase of density with decreasing radius which leads to very large geometrical extensions and large temperature differences between the inner and outer parts. The spectra show a large IR excess and a small Balmer jump which may be either in absorption or in emission. For the parameters considered (T_{eff} = 10^4, 1.5 x 10^4, 2 x 10^4K, R = 10^{11} cm, solar composition), most lines are in absorption. The effects of both modifications in the temperature structure (e.g. by heating from shock fronts) and changes in the abundances of the heavy elements on the emergent spectra are briefly discussed. 13 refs., 11 figs.

24824 (LA-UR-90-876) **Multi-wavelength observations of novae in outburst.** Starrfield, S. (Los Alamos National Lab., NM (USA)). Los Alamos National Lab., NM (USA). [1989]. 12p. Sponsored by U.S. DOE Management & Administration; National Science Foundation. DOE Contract W-7405-ENG-36. AST85-16173;AST88-18215. (CONF-8906225-5: Physics of classical novae: IAU colloquium no. 122, Madrid (Spain), 27-30 Jun 1989). Order Number DE90008934. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This review serves as the introduction to the observational studies of novae and I will mention a number of results that will be emphasized by other reviewers. Therefore, I will try to provide the physical framework for multi-wavelength observations as applied to studies of novae. I divide the outburst into phases based on the physical effects that are occurring at that time. The first phase is the rise to bolometric maximum and occurs on a convective time scale. The second phase is the rise to visual maximum and occurs on the time scale for the envelope to expand to ~10^{12}cm. The third phase is the time when the nova is emitting at constant bolometric luminosity, but declining optical magnitude, and it lasts until most of the accreted material has been either exhausted or eroded from the surface of the white dwarf. The fourth and final phase is the return is the return to quiescence (turn-off phase) and it occurs at the time that nuclear burning is ending. I will discuss each of these phases in turn and end with a discussion. 36 refs.

24825 (N-90-14164) **Unitarity limits on the mass and radius of dark matter particles.** Griest, K.; Kamionkowski, M. Fermi National Accelerator Lab., Batavia, IL (USA). Sep 1989. 10p. (NASA-CR-186079;NAS-1.26:186079;FERMILAB-PUB-89/205-A;CFPA-TH-89-013). Available from NTIS, PC A02/MF A01.

Using partial wave unitarity and the observed density of the Universe, it is show that a stable elementary particle which was once in thermal equilibrium cannot have a mass greater than 340 TeV. An extended object which was once in thermal equilibrium cannot have a radius less than 7.5 x 10(exp -7) fm. A lower limit to the relic abundance of such particles is also found.

24826 (N-90-14180) **The grand unified photon spectrum: A coherent view of the diffuse extragalactic background radiation.** Ressell, M.T.; Turner, M.S. Fermi National Accelerator Lab., Batavia, IL (USA). Oct 1989. 32p. (NASA-CR-186077;NAS-1.26:186077;FERMILAB-PUB-89/214-A). Available from NTIS, PC A03/MF A01.

The spectrum of diffuse extragalactic background radiation (DEBRA) at wavelengths from 10(exp 5) to 10(exp -24) cm is presented in a coherent fashion. Each wavelength region, from the radio to ultra-high energy photons and cosmic rays, is treated both separately and as part of the grand unified photon spectrum (GUPS). A discussion of, and references to, the relevant literature for each wavelength region is included. This review should provide a useful tool for those interested in diffuse backgrounds, the epoch of galaxy formation, astrophysical/cosmological constraints to particle properties, exotic early Universe processes, and many other astrophysical and cosmological enterprises. As a worked example, researchers derive the cosmological constraints to an unstable-neutrino spies (with arbitrary branching ratio to a radiative decay mode) that follow from the GUPS.

24827 (N-90-15016) **Supersymmetric dark matter above the W mass.** Griest, K.; Kamionkowski, M.; Turner, M.S. California Univ., Berkeley, CA (USA). Nov 1989. 62p. (NASA-CR-186168;NAS-1.26:186168;FERMILAB-PUB-89/239-A;CFPA-TH-89-016). Available from NTIS, PC A04/MF A01.

The cosmological consequences are studied for the minimal supersymmetric extension of the standard model in the case that the neutralino is heavier than W. The cross section was calculated for annihilation of heavy neutralinos into final states containing gauge and Higgs bosons (XX yields WW, ZZ, HH, HW, HZ), where X is the lightest, nth neutralino and the results are compared with the results with those previously obtained for annihilation into fermions to find the relic cosmological abundance for the most general neutralino. The new channels are particularly important for the Higgsino-like and mixed-state neutralinos, but are sub-dominant (to the fermion-antifermion annihilation channels) in the case that the neutralino is mostly a gaugino. The effect of the top quark mass is also considered. Using these cross sections and the cosmological constraint omega(sub X)h squared is less than or approximately 1, the entire range of cosmologically acceptable supersymmetric parameter space is mapped and a very general bound on the neutralino mass is discovered. For a top quark mass of less than 180 GeV, neutralinos heavier than 3200 GeV are cosmologically inconsistent, and if the top quark mass is less than 120 GeV, the bound is lowered to 2600 GeV. Neutralino states that are mostly gaugino are constrained to be lighter than 550 GeV. It is found that a heavy neutralino that contributes omega(sub X) is approximately 1 arises for a very wide range of model parameters and makes, therefore, a very natural and attractive dark matter candidate.

24828 (N-90-15025) **Laboratory evaluation and application of microwave absorption properties under simulated conditions for planetary atmospheres. Annual Status report, 1 February-31 October 1989.** Steffes, P.G. Georgia Inst. of Tech., Atlanta, GA (USA). Oct 1989. 50p. (NASA-CR-185916;SA-SR-12;NAS-1.26:185916). Available from NTIS, PC A03/MF A01.

Radio absorptivity data for planetary atmospheres obtained from spacecraft radio occultation experiments and earth-based radio astronomical observations can be used to infer abundances of microwave absorbing atmospheric constituents in those atmospheres, as long as reliable information regarding the microwave absorbing properties of potential constituents is available. Work performed has shown that laboratory measurements of the millimeter-wave opacity of ammonia between 7.5 mm and 9.3 mm and also at the 3.2 mm wavelength require a different lineshape to be used in the theoretical prediction for millimeter-wave ammonia opacity than was previously used. The recognition of the need to make such laboratory measurements of simulated planetary atmospheres over a range of temperatures and pressures which correspond to the altitudes probed by both radio occultation experiments and radio astronomical observations, and over a range of frequencies which correspond to those used in both radio occultation experiments and radio astronomical observations, has led to the development of a facility at Georgia Tech which is capable of making such measurements. It has been the goal of this investigation to conduct such measurements and to apply the results to a wide range of planetary observations, both spacecraft and earth-based, in order to determine the identity and abundance profiles of constituents in those planetary atmospheres.

24829 Effects of strange particles on neutron-star cores. Kapusta, J.I. (School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455 (USA)); Olive, K.A. *Physical Review Letters (USA),* 64(1): 13-15 (1 Jan 1990).

We show that uncertainties in the strength of interactions of hyperons among themselves and with nucleons lead to an uncertainty in the maximum allowed neutron-star mass of nearly a factor of 2, even if the properties of nuclear and neutron matter were known with infinite precision around normal nuclear density and below. The possibility of a transition to quark matter places some constraint on the strength of the hyperonic interactions.

24830 Cosmic-string evolution. Bennett, D.P. (Physics Department, Princeton University, Princeton, New Jersey 08540 (USA)); Bouchet, F.R. *Physical Review Letters (USA),* 63(26): 2776-2779 (25 Dec 1989).

We summarize the results of high-resolution simulations of cosmic-string evolution in an expanding universe. The string network is found to relax to a scaling solution in accordance with Kibble's "one-scale model." However, the long strings are found to have significant structure on scales much smaller than the scale length of the long-string network, and the size of the stable loops produced by the network is determined by this small-scale structure. This implies that the long strings rather than the loops will probably play a dominant role in the observational effects of cosmic strings.

24831 Halo γ rays from cold-dark-matter annihilation. Freese, K. (Department of Astronomy, University of California, Berkeley, California 94720 (US)); Silk, J. *Physical Review, D (Particles Fields) (USA),* 40(12): 3828-3833 (15 Dec 1989).

Halo γ-ray production by annihilation of dark-matter candidates is studied. In the case of massive Dirac neutrinos, both e^+e^- accelerator data as well as Monte Carlo simulations of the hadronization have been used to study the photon signal due to annihilation of weakly interacting massive particles in the galactic halo. The diffuse γ-ray signal is found to be potentially detectable with Gamma Ray Observatory. The signal from supersymmetric particles is also detectable if the halo is flattened and thus the local dark-matter density is large.

24832 General-relativistic plasma physics in the early Universe. Holcomb, K.A. (Computation Center, University of Texas at Austin, Austin, Texas 78712 (USA)); Tajima, T. *Physical Review, D (Particles Fields) (USA),* 40(12): 3809-3818 (15 Dec 1989).

We apply the "3+1" formalism of Thorne and Macdonald to construct the linearized theory of a general-relativistic electron-positron plasma in the early Universe. Close formal correspondence between the theory of such plasmas and that of their special-relativistic counterparts is demonstrated. The time variation of the plasma modes due to the expansion of the background is determined for the case of a radiation-dominated Universe; it is found that the frequencies of the basic modes redshift like the frequency of a free photon. A simple kinetic argument is used to justify the neglect of creation and annihilation (collisional) effects. The formulation is sufficiently straightforward to be readily amenable to numerical implementation. Our results can be applied to the study of the origin of primordial intergalactic magnetic fields, as well as to the problem of matter fluctuations in the early Universe.

24833 Some problems with extended inflation. Weinberg, E.J. (Physics Department, Columbia University, New York, New York 10027 (US)). *Physical Review, D (Particles Fields) (USA),* 40(12): 3950-3959 (15 Dec 1989).

The recently proposed extended inflation scenario is examined. Upper bounds on the Brans-Dicke parameter ω are obtained by requiring that the recovery from the supercooled regime be such that the presently observed Universe could have emerged. These bounds are well below the present-day experimental limits, implying that one must use models which have a potential to fix the present value of the Brans-Dicke-like scalar field. The implications for extended inflation in such models are discussed.

24834 Cosmic strings and ultrahigh-energy cosmic rays. Bhattacharjee, P. (Department of Astronomy and Astrophysics, The University of Chicago, 5640 S. Ellis Avenue, Chicago, Illinois 60637 (US)— NASA/Fermilab Astrophysics Center, Fermi National Accelerator Laboratory, P.O. Box 500, Batavia, Illinois 60510). *Physical Review, D (Particles Fields) (USA),* 40(12): 3968-3975 (15 Dec 1989).

We calculate the flux of ultrahigh-energy protons due to the process of "cusp evaporation" from cosmic-string loops. For the "standard" value of the dimensionless cosmic-string parameter $\epsilon = G\mu \approx 10^{-6}$, the flux is several orders of magnitude below the observed cosmic-ray flux of ultrahigh-energy protons. However, the flux at any energy initially increases as the value of ϵ is decreased. This at first suggests that there may be a lower limit on the value of ϵ, which would imply a lower limit on the temperature of a cosmic-string-forming phase transition in the early Universe. However, our calculation shows that this is not the case—the particle flux at any energy reaches its highest value at $\epsilon \approx 10^{-15}$ and it then *decreases* for further decrease of the value of ϵ. This is due to the fact that for too small values of ϵ ($<10^{-15}$) the energy loss of the loops through the cusp evaporation process itself (rather than gravitational energy loss of the loops) becomes the dominant factor that controls the behavior of the number density of the loops at the relevant times of emission of the particles. The highest flux at any energy remains at least 4 orders of magnitude below the observed flux. There is thus no lower limit on ϵ.

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24835 (AD-A-215140/5/XAB) **Multi-radar mapping of auroral convection.** Foster, J.C.; Turunen, T.; Pollari, P.; Kohl, H.; Wickwar, V.B. Haystack Observatory, Westford, MA (USA). 1989. 10p. Available from NTIS, PC A02/MF A01.

Pub. in Advances in Space Research, Vol. 9, No. 5, (5)19-(5)27(1989).

Simultaneous radar azimuth scans with the Millstone Hill, Sondrestrom, and EISCAT incoherent scatter radars produce maps of the ionospheric convection electric field at high latitudes which span 10 hours of magnetic local time. A series of convection snapshots made during an interval of increasing geomagnetic activity indicate that the large-scale convection pattern maintains a two-cell character during substorm onset and that average convection models derived from radar data provide a reasonable representation of the large-scale convection pattern during dynamically varying conditions.

24836 (AD-A-215311/2/XAB) **Orgins of enhanced field-aligned current at the edge of an auroral arc.** Greenspan, M.E. Regis Coll., Weston, MA (USA). Research Center. 1 Sep 1989. 8p. (SCIENTIFIC-6). Available from NTIS, PC A02/MF A01.

Rocket and radar observations of auroral arcs indicate that the upward field-aligned currents associated with such arcs sometimes are larger at their edges than within the arcs. One set of observations was made by instruments on the Porcupine F4 rocket. Porcupine F4 measured a fourfold increase in the magnitude of the upward field-aligned current at the edge of an auroral arc over its value in the arc's center, while the energy of the peak in the electron differential flux decreased at the edge of the arc and the electron distribution function remained nearly isotropic in pitch angle throughout the arc. One mechanism which has been proposed to explain the creation of auroral arcs is the adiabatic acceleration of magnetospheric electrons through a field-aligned electrostatic potential. The upward field-aligned current which results is a function of density and parallel and perpendicular temperatures of the magnetospheric electron population as well as the magnitude and altitude of the electrostatic potential drop. If the arc traversed by Porcupine F4 was created in this way, the increase in upward current at the edge of the arc cannot be explained solely by an increase in the altitude of the top of the field-aligned potential drop. Rather, an increase in the density, a decrease in the perpendicular temperature of the magnetospheric electron population at the edge of the arc, or both are needed to explain the observed increase in upward field-aligned current.

24837 (LA-UR-90-1000) **Dynamics of cavitons in strong Langmuir turbulence.** DuBois, D.F.; Rose, H.A.; Russell, D. Los Alamos National Lab., NM (USA). [1990]. 56p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900264-4: Topical conference on research trends in nonlinear and relativistic effects in plasmas, San Diego, CA (USA), 5-8 Feb 1990). Order Number DE90008918. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Recent studies of Langmuir turbulence as described by Zakharov's model will be reviewed. For parameters of interest in laser-plasma experiments and for ionospheric hf heating experiments a significant fraction of the turbulent energy is in nonlinear "caviton" excitations which are localized in space and time. A local caviton model will be presented which accounts for the nucleation-collapse-burnout cycles of individual cavitons as well as their space-time correlations. This model is in detailed agreement with many features of the electron density fluctuation spectra in the ionosphere modified by powerful hf waves as measured by incoherent scatter radar. Recently such observations have verified a prediction of the theory that "free" Langmuir waves are emitted in

the caviton collapse process. Observations and theoretical considerations also imply that when the pump frequency is slightly lower than the ambient electron plasma frequency cavitons may evolve to states in which they are ordered in space and time. The sensitivity of the high frequency Langmuir field dynamics to the low frequency ion density fluctuations and the related caviton nucleation process will be discussed. 42 refs., 12 figs.

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Refer also to citation(s) 23903, 24013, 24023, 24100, 24197, 24731, 25067, 25117

24838 (CLM-R–294) **Atomic and molecular data for fusion, Pt. 3: Recommended cross sections and rates for electron impact ionization of atoms and ions: copper to uranium.** Higgins, M.J. (Queen's Univ., Belfast, Northern Ireland (UK)); Hughes, J.G.; Gilbody, H.B.; Smith, F.J.; Lennon, M.A.; Bell, K.L.; Kingston, A.E. UKAEA Culham Lab., Abingdon (UK). 1989. 126p. Contract EMR/452M. Available from H.M. Stationery Office, London, price Pound 14.00. Available from H.M. Stationery Office, London, price Pound 14.00.

Experimental and theoretical cross section data for electron impact ionization of atoms and ions from Copper to Uranium have been assessed. Based on this assessment a recommended cross section has been produced for each species. This has been used to evaluate recommended Maxwellian rate coefficients over a wide range of temperatures. Convenient analytic expressions have been obtained for the recommended cross sections and rate coefficients. The data are presented in both graphical and tabular form. Estimates of the reliability of the recommended data are also given. (author).

24839 (DOE/ER/13405–T3) **Picosecond laser study of polyatomic molecules: Progress report, [1989].** Kwok, Hoi S. State Univ. of New York, Buffalo, NY (USA). Dept. of Electrical and Computer Engineering. 10 Mar 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-85ER13405. Order Number DE90008647. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the photodissociation of NO_2 by lasers and the improvement to femtosecond spectroscopy measurement. (LSP)

24840 (DOE/ER/13421–T1) **Near resonant absorption by atoms in intense fluctuating fields: Progress report, August 1, 1989–July 31, 1990.** Joint Inst. for Lab. Astrophysics, Boulder, CO (USA). [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-85ER13421. Order Number DE90008643. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Using an atomic beam apparatus, we have carried out comprehensive measurements of fluorescence intensity, and fluctuations (variance) in the fluorescence intensity, from the $3S_{1/2}$ ($F = 2$, $M_F = 2$) $\rightarrow$ $3P_{3/2}$ ($F = 3$, $M_F = 3$) transition in atomic sodium, in a laser driving field on which well-characterized synthesized phase fluctuations have been imposed. These data are taken as a function of detuning of the laser from exact resonance with the transition, and for laser fields modulated with characteristically different bandwidths and amplitudes of phase noise. The experimental results are compared in detail with predictions of recently developed theoretical treatments. The methods are being extended to experimental studies of the role of phase fluctuations in four-wave mixing. 4 refs., 1 fig.

24841 (DOE/ER/13549–4) **Electron transfer, ionization, and excitation atomic collisions: Progress report.** Winter, T.G.; Alston, S.G. Pennsylvania State Univ., University Park, PA (USA). Dept. of Physics. [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13549. Order Number DE90008987. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Basic atomic-collision processes at intermediate and high energies are being studied theoretically at Penn State by Alston and Winter. In the high velocity regime, single-electron capture is treated using a high order multiple-scattering approach; extensive comparison with experiment and analysis of mechanisms have been made. Fitting the calculated amplitude with a simple analytic form, the asymptotic velocity dependence of the cross section is obtained. The effect on the capture amplitude of altering the inner part of the internuclear potential has also been explored. In the intermediate velocity regime, earlier work on collisions between protons and hydrogenic-ion targets using a coupled-state approach is being extended to the two-electron helium target. 29 refs.

24842 (DOE/SF/16496–T1) **A new technique for guiding of electron beams: Final report, October 1, 1986–March 1, 1990.** Radziemski, L.J. New Mexico State Univ., Las Cruces, NM (USA). Arts and Sciences Research Center. 1 Mar 1990. 29p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC03-86SF16496. Order Number DE90008660. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The contract objective was to demonstrate the possibility of guiding of an electron beam through a low pressure excited working gas other than benzene. This experimental and modeling study resulted in the following conclusions: (1) Guiding of a 10 kA electron beam through krypton with a 2 + 1 ionization process excited by ArF is feasible with ArF energies of less than 10 J; (2) Guiding through a gas which requires a 2 (or more) photon excitation process will not provide significant savings in laser energy. This is independent of whether or not the excited state is a Rydberg state; (3) The ideal medium for propagation from an energetics point of view would be a working gas which could be excited to a state near the ionization energy by a single photon; (4) Guiding through gases with non-resonant ionization of a working gas (e.g., xenon by KrF) will be feasible at KrF irradiances on the order of 10^{10} W/cm^2; (5) There is a three photon resonance in atomic argon which could be useful for exciting and photoionizing that species. The maximum excitation cross section has been calculated for the first time; (6) Guiding with Rydberg states remains experimentally untested; and (7) The IPROP code was modified to include collisional and field ionization effects, the first time such a modification has been incorporated into a sophisticated electron beam propagation model. 27 refs., 5 figs., 5 tabs.

24843 (JINR–13-88-621) **Use of the molecular and multicharged ions during ion implantation.** Kornarzynski, K. (Uniwersytet Marii Curie-Sklodowskiej, Lublin (Poland). Inst. Fizyki); Kiszczak, K.; Maczka, D.; Latuszynski, A.; Yushkevich, Yu.V.; Partyka, J. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 10p. (In Russian). Order Number DE90620558. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The experimental results on hollow-cathode ion source investigation are presented, the optimal conditions for production of molecular and multicharged ions of a number of elements for ionic implantation are obtained. 10 refs.; 5 figs.; 1 tab.

24844 (JINR-E–4-88-849) **New series in spectra of muonic molecules.** Ishihara, T. (Tsukuba Univ., Ibaraki (Japan)); Fukuda, H.; Hara, S.; Matveenko, A.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 8p. Order Number DE90620538. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Abnormal parity bound states of muonic molecules are calculated for the first time. Two molecules $pd\mu$ and $pt\mu$ have a low-bound state. 12 refs.; 2 figs.; 2 tabs.

24845 (JINR-R–1-88-741) **Measurement of cross section of positronium ultrarelativistic atom interaction with carbon.** Afanas'ev, L.G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems); Balalykin, N.I.; Gorchakov, O.E. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 16p. (In Russian). Order Number DE90620541. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Total cross section of positronium ultrarelativistic atom (A_{2e}) interaction with carbon atoms has been measured. Neutral pion decay $\pi^0 \rightarrow \gamma + A_{2e}$ was a source of A_{2e} γ-factors of atoms ($800 < \gamma < 2000$) in the momentum range investigated were by three orders more than the values measured in other experiments on atom-atom collisions. In this range of γ-factors the cross section has to be equal to its asymptotic value. The total cross section measured equals $\sigma_{tot} = (16 \pm {}^{16}_{6}) \times 10^{-19}$ cm^2/atom. The total cross section value obtained does not contradict the calculated value of

σ^{th}_{tot}=5.7x10^{-19} cm^2/atom taking into account the Coulomb interaction of A_{2e} with carbon. At the same time the comparison of σ_{tot} and σ_{tot}^{th} does not exclude the existence of other mechanisms of ionization or excitation of ultrarelativistic A_{2e} by matter leading to a considerable cross section rising. 38 refs.; 4 figs.; 2 tabs.

24846 (JINR-R–2-88-874) **Interaction cross sections of ultrarelativistic hydrogen and positronium atoms with hydrogen, carbon, nitrogen and argon atoms.** Kuptsov, A.V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems); Pak, A.S.; Saakyan, S.B. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 15p. (In Russian). Order Number DE90620542. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Interaction cross sections of hydrogen and positronium atoms with hydrogen, carbon, nitrogen and argon atoms are calculated in the first Born approximation. The atomic formfactors and incoherent scattering functions based on the Hartree-Fock atomic wave functions have been used for C, N and Ar atoms description. Calculated hydrogen ionization cross sections are compared with the theoretical cross sections published in the literature and with the experimental cross sections measured at low energies. Comparison permits to conclude that uncertainty of the theoretical ionization cross section values for hydrogen does not exceed ± 10%. Hydrogen and positronium cross section calculations exactness is the same. The calculated total positronium interaction cross section with the carbon atoms is compared with the experimental cross section in the γ-factor interval from 800 to 2000. 25 refs.; 2 figs.; 5 tabs.

24847 (JINR-R–4-88-640) **Convergence of hyperspherical adiabatic expansion for helium-like systems.** Abrashkevich, A.G. (Uzhgorodskij Gosudarstvennyj Univ., Uzhgorod (Ukrainian SSR)); Abrashkevich, D.G.; Pojda, V.Yu.; Vinitskij, S.I.; Kaschiev, M.S.; Puzynin, I.V. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 6p. (In Russian). Order Number DE90620526. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to the International Workshop Microscopic Methods in Theory of a Few Paticle Systems, Kalinin, August 1988 and to J. Phys., B.

The convergence of hyperspherical adiabatic expansion has been studied numerically. The spectral problems arising after separation of variables are solved by the finite-difference and finite element methods. The energies of the ground and some doubly excited staes of a hydrogen ion are calculated in the six-channel approximation within the 10^{-4} a.u. accuracy. Obtained results demonstrate a rapid convergence of the hyperspherical adiabatic expansion. 14 refs.; 5 tabs.

24848 (JINR-R–4-88-746) **Adiabatic description of two-electron resonant states by the method of extrapolation in coupling constant.** Abrashkevich, A.G. (Uzhgorodskij Gosudarstvennyj Univ., Uzhgorod (Ukrainian SSR)); Abrashkevich, D.G.; Khimich, I.V.; Vinitskij, S.I.; Puzynin, I.V. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 20p. (In Russian). Order Number DE90620543. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Phys. Scr.

Analytical properties in energy and coupling of multichannel scattering matrix and localization and character of poles motion in complex energy and coupling constant planes are studied in the framework of adiabatic hyperspherical representation for two-electron atomic systems. On this basis a method for obtaining characteristics of resonant states with the help of extrapolation in coupling constant of corresponding characteristics of bound states is developed. This extrapolation is realized with the help of Pade approximants of second type. The considered approach is used for calculating the position and width of $^1P^0$ shape resonance of negative hydrogen ion. 48 refs.; 6 tabs.

24849 (JINR-R–4-88-747) **Sticking probability for μCF reaction dtμ → μ ^{4}He+n in adiabatic hyperspherical approach.** Abrashkevich, A.G. (Uzhgorodskij Gosudarstvennyj Univ., Uzhgorod (Ukrainian SSR)); Vinitskij, S.I.; Kaschiev, M.S.; Puzynin, I.V. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 15p. (In Russian). Order Number DE90622145. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Phys. Lett., B.

Basic characteristics of vibrational states of the mesic molecules dtμ(J=0) are calculated in the two-level approximation of the adiabatic hyperspherical approach to the three-body problem. The obtained wave functions are applied to compute the sticking probability ω_s of the muon to helium in the muon catalysis. The hyperradius R used as the adiabatic variable has allowed correct definition of boundary conditions at the point of triple collision - the center of inertia of a three-body system. The dependence of ω_s on the parameters of the computational scheme is studied and the accuracy of results is estimated. The values of ω_s for the ground ω_s(J=0, v=0)=0.340x10^{-2} and the first vibrational ω_s(J=0, v=1)=0.345x10^{-2} states have been found. These values provide lower estimation as compared with the known experimental data. Possibility of improving the obtained results is analysed. 29 refs.; 4 figs.; 6 tabs.

24850 (JINR-R–11-88-745) **HSATOM - computer code package for calculation of spectral characteristics of helium-like systems in hyperspherical coordinates.** Abrashkevich, A.G. (Uzhgorodskij Gosudarstvennyj Univ., Uzhgorod (Ukrainian SSR)); Griga, Yu.L.; Vinitskij, S.I.; Kaschiev, M.S.; Puzynin, I.V. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 24p. (In Russian). Order Number DE90622149. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Description is given for the computer code package HSATOM assigned to compute the energy levels and wave functions of helium-like systems in the hyperspherical adiabatic approach with an accuracy of about 10^{-4} a.u. Approximation of the corresponding Sturm-Liouville problems is made with the difference scheme of the second order of accuracy. The obtained algebraic problem is solved subspace iteration method. Work of the package is demonstrated by calculating the ground state of a negative hydrogen ion. 20 refs.; 1 fig.

24851 (KFTI–88-13) **Relaxation of electron-impurity system in electric field and stabilization of the kinetic equation solutions.** Ivanchenko, E.A. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 10p. (In Russian). Order Number DE90620544. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Consideration is given to relaxation of electron-impurity system in electrc field and behaviour of the kinetic equation solution for isotropic distribution function n(e,t) at high time values. Conditions were found, under which the distribution function spreads and tends to zero (the kinetic equation is reduced to unidimensional parabolic equation of the second order without lowest degree terms). 5 refs.

24852 (UCRL–21298) **Spectral line shape code for multi-electron emitters: Final report.** Calisti, A. (Aix-Marseille-1 Univ., 13 - Marseille (France)); Khelfaoui, F.; Stamm, R.; Sylvander, L.; Talin, B. Lawrence Livermore National Lab., CA (USA); Aix-Marseille-1 Univ., 13 - Marseille (France). Mar 1989. 31p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008526. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report describes a computer code providing theoretical line profiles of multielectron radiators in plasmas. The line profiles are calculated for a selected spectral range, in the presence of natural broadening, doppler and stark effect. The model used for the description of stark effect assumes that the plasma and atomic structure parameters are such that the static ion microfield approximation and the model of a binary collision electronic operator are valid. Whereas an electronic collision operator can usually safely be used, neglecting ion motion requires that the width of the line is much larger than the typical fluctuation frequency of the ion microfield (ion plasma frequency). A careful check for the validity of this approximation has to be done for hot and dense plasma conditions. Breakdown of the static approximation occur especially for hydrogenic emitters. For multielectron emitters a large validity domain of the static ion approximation is usually found. In this static ion model, an average is performed over a static microfield distribution. For this quantity, the APEX model is used, which allows for calculations in the coupled plasma domain. 4 figs.

24853 Electric dipole moment and hyperfine properties of bromoacetylene in the ground and first excited C–H stretching vibrational states. Bass, S.M. (Department of Chemistry, University of Rochester, Rochester, New York 14627 (US)); DeLeon, R.L.; Muenter, J.S. *Journal of Chemical Physics (USA)*, 92(1): 71-75 (1 Jan 1990).

Molecular beam electric resonance spectroscopy, combined with color center laser excitation, has been used to measure the electric dipole moment and Br hyperfine properties of bromoacetylene in its ground and first excited C–H stretching vibrational states. For the $HCC^{79}Br$, v=0: μ=0.229 62(1) D, eQq=648.113(3) MHz, C_{Br}=6.4(3) kHz, and B=4000.07 MHz. For the $HCC^{79}Br$, v=1: μ=0.248 82(1) D, eQq=648.160(2) MHz, C_{Br}=7.0(3) kHz, and B=3992.79 MHz. For the $HCC^{81}Br$, v=0: μ=0.229 56(1) D, eQq=541.430(1) MHz, C_{Br}=7.4(1) kHz, and B=3978.46 MHz. For the $HCC^{81}Br$, v=1: μ=0.248 61(1) D, eQq=541.464(3) MHz, C_{Br}=7.6(4) kHz, and B=3971.34 MHz. The vibrational band origin for the C–H stretching vibration is 3367.7(2) cm^{-1}.

24854 Reduced form for the general-state multicenter integral from an integro-differential transform. Straton, J.C. (Department of Physics, Cardwell Hall, Kansas State University, Manhattan, Kansas 66506 (US)). *Physical Review, A (General Physics) (USA)*, 41(1): 71-77 (1 Jan 1990).

In a previous paper Gaussian transforms were utilized to obtain the analytically reduced form for the class of multicenter integrals containing a product of hydrogenic orbitals for s states, Yukawa or Coulomb potentials, and plane waves. In the present paper a related transformation is developed for nonspherical functions, leading to the reduced form for multicenter integrals that include hydrogenic orbitals representing states of arbitrary angular momentum.

24855 Measurement of the Lamb shift in the n = 2 state of muonium. Woodle, K.A. (Gibbs Laboratory, Physics Department, Yale University, New Haven, Connecticut 06520 (USA)); Badertscher, A.; Hughes, V.W.; Lu, D.C.; Ritter, M.W.; Gladisch, M.; Orth, H.; zu Putlitz, G.; Eckhause, M.; Kane, J. *Physical Review, A (General Physics) (USA)*, 41(1): 93-105 (1 Jan 1990). DOE Contract AC02-76ER03075.

We report the results of a measurement of the Lamb shift in the n=2 state of muonium. Muonium atoms in the metastable 2S state were produced by the beam-foil method and the formation rate was determined by observation of the Ly-α photons emitted when the metastable atoms were quenched in a static electric field. The Lamb shift ($scrS_{Mu}$) was measured through observation of the microwave-induced $2\ ^2S_{1/2}$–$2\ ^2P_{1/2}$ transition with the result $scrS_{Mu}=1042_{-23}^{+21}$ MHz. This result is in agreement with the current theoretical value.

24856 Doppler-free saturation spectroscopy of lutetium isotopes through resonance-ionization mass spectrometry. Fearey, B.L. (Los Alamos National Laboratory, Los Alamos, New Mexico (US)); Parent, D.C.; Keller, R.A.; Miller, C.M. *Journal of the Optical Society of America, Part B: Optical Physics (USA)*, 7(1): 3-8 (Jan 1990). DOE Contract W-7405-ENG-36.

Saturation spectroscopy with resonance-ionization mass spectrometry detection was used to obtain Doppler-free spectra of the $^2D^o_{3/2}$←$^2D_{3/2}$ transition of lutetium at 22 125 cm^{-1} in unenriched, naturally occurring samples. Analysis of the spectra yielded the hyperfine coupling constants of ^{175}Lu and ^{176}Lu for this transition. Applications to isotopically selective photoionization and large-ratio isotopic analysis are discussed.

24857 Infrared radio-frequency double-resonance spectra of CH_3OH in the CH_3 deformation state and torsionally excited states. Petersen, J.C. (Department of Physics and Astronomy, The University of Alabama, Tuscaloosa, Alabama 35487-0324 (US)). *Journal of the Optical Society of America, Part B: Optical Physics (USA)*, 7(2): 159-163 (Feb 1990).

The infrared radio-frequency double-resonance technique has been used to study seven sets of coupled transitions involving torsionally excited states of the vibrational ground state and the CO-stretch state of CH_3OH. One double-resonance signal due to a transition in the CH_3-deformation state has also been observed. The observations confirm previously proposed assignments of far-infrared laser lines and have allowed the determination of A-state asymmetry parameters, including $S^{CO}(122)$, $T^{CO}(122)$, and $S^{CH-def}(013)$.

24858 Multiconfiguration Hartree-Fock calculation of the photoionization of the Cs 7d excited state. Saha, H.P. (Department of Physics, University of Central Florida, Orlando, Florida 32816-0993 (US)). *Physical Review, A (General Physics) (USA)*, 41(1): 174-180 (1 Jan 1990).

The numerical multiconfiguration Hartree-Fock method is used to calculate the photoionization cross section for the Cs 7d excited state. The electron correlation and the dynamical core-polarization effects, which are very important for photoionization-cross-section calculations of the cesium atom, have been taken into account in an *ab initio* manner through the configuration-interaction procedure. A minimum has been found in the total photoionization cross section. The calculation of the photoionization angular-distribution asymmetry parameter is proved to be an excellent test to determine the existence and location of the minimum in the cross section. The length and velocity forms of the cross section and the asymmetry parameter are found to be in excellent agreement over the entire incident photon energy range considered, suggesting that converged results may be obtained in this interval with the present approach. The results obtained are compared with the recent experimental measurements of the absolute photoionization cross section and are found to be in good agreement.

24859 Differential cross sections for multiple ionization of Ne and Ar in collisions with fast protons. Kamber, E.Y. (J. R. Macdonald Laboratory, Department of Physics, Kansas State University, Manhattan, Kansas 66506 (US)); Cocke, C.L.; Cheng, S.; Varghese, S.L. *Physical Review, A (General Physics) (USA)*, 41(1): 150-157 (1 Jan 1990).

Differential cross sections for single and multiple ionization of Ne and Ar by protons have been measured at impact energies of 3 and 6 MeV, and at proton scattering angles between 0.1 and 0.9 mrad. The recoil ions formed in the collision processes were extracted from the collision region and detected in coincidence with the scattered protons. Their charge states were determined by their flight times. The experimental differential cross sections for single and multiple ionization are qualitatively explained by a simple model that takes into account the contributions of scattering from the electrons and from the target nucleus. The model indicates that ionization by hard proton-electron collisions remains the largest contributor to single and multiple ionization of both Ne and Ar for projectile scattering angles larger than 0.1 mrad. The ratio of double-to-single ionization cross sections for Ne and Ar increases with increasing proton scattering angle, suggesting an increasing importance of inner-shell ionization at small impact parameters.

24860 Electron-impact ionization cross-section measurements for U^{10+}, U^{13+}, and U^{16+}. Gregory, D.C. (Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6372 (USA)); Huq, M.S.; Meyer, F.W.; Swenson, D.R.; Sataka, M. *Physical Review, A (General Physics) (USA)*, 41(1): 106-115 (1 Jan 1990). DOE Contract AC05-84OR21400.

Absolute measurements are presented for electron-impact single ionization of U^{10+}, U^{13+}, and U^{16+}, and for double ionization of U^{10+} and U^{13+} from below the thresholds to 1500 eV. Metastable components are observed in all three incident-ion beams. The single-ionization cross sections are enhanced due to indirect ionization processes by factors of 4–20 near their peaks, and the double-ionization cross sections are apparently also dominated by indirect ionization. Good agreement is found with distorted-wave calculations for total ionization of U^{16+}, the only case where detailed calculations are available for comparison. Individual or closely spaced resonances are clearly resolved in the single-ionization channels for U^{13+} and U^{16+}.

24861 Experimental and theoretical cross sections for electron-impact ionization of Tl^{5+}. Chantrenne, S.J. (Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6372 (USA)); Gregory, D.C.; Buie, M.J.; Pindzola, M.S. *Physical Review, A (General Physics) (USA)*, 41(1): 140-144 (1 Jan 1990). DOE Contract W-7405-ENG-48.

Absolute cross sections for electron-impact ionization of Tl^{5+} have been measured from below threshold to 1500-eV collision energies. Distorted-wave calculations including direct ionization and excitation autoionization from the $3s^23p^5$ ground state and from the $3s^23p^43d$ excited configurations have been performed. Comparison of experiment and theory indicates that about 33% of the incident ions were in metastable configurations. Ionization rate coefficients and fitting parameters derived from the experimental results are also presented.

24862 Relativistic cross sections for excitation of highly charged ions to specific magnetic sublevels by an electron beam. Zhang, H.L. (Department of Astronomy, Pennsylvania State University, University Park, Pennsylvania 16802 (USA)); Sampson, D.H.; Clark, R.E.H. *Physical Review, A (General Physics) (USA),* 41(1): 198-206 (1 Jan 1990). DOE Contract FG02-85ER53208.

A program has been developed for making calculations of fully relativistic distorted-wave cross sections for excitation of highly charged ions to specific magnetic sublevels M_f by a beam of electrons. The approach uses the same Dirac-Fock-Slater potential for all electrons and is expected to be accurate for nuclear charge number $Z \gtrsim 2.5N$, where N is the number of bound electrons per ions. To our knowledge there is at present no other fully relativistic program available with which we could compare results for this type of cross section. However, the present results for He-like, Li-like, and Ne-like iron and for Ne-like molybdenum are compared with other partially relativistic results, and generally good agreement is obtained for these ions. It is expected that the present program will be useful for comparison with and interpretation of experimental results for very highly charged ions, such as those obtained in electron-beam ion-trap experiments at Livermore [R. E. Marrs *et al.*, Phys. Rev. Lett. 60, 1715 (1988)].

24863 Spectral Data and Grotrian Diagrams for Highly Ionized Iron, Fe VIII-XXVI. Shirai, T. (Japan Atomic Energy Research Institute, Tokai-mura 319-11, (Japan)); Funatake, Y.; Mori, K.; Sugar, J.; Wiese, W.L.; Nakai, Y. *Journal of Physical and Chemical Reference Data (USA),* 19(1): 127-275 (Jan 1990).

Wavelengths, energy levels, level classifications, oscillator strengths, and atomic transition probabilities of the iron ions Fe VIII to Fe XXVI are critically reviewed and tabulated. Grotrain diagrams are also presented to provide graphical overviews. The literature has been surveyed to March 1988.

24864 Rotational autoionization of *np* Rydberg series of D_2. Pratt, S.T. (Argonne National Laboratory, Argonne, Illinois 60439 (US)); Dehmer, P.M.; Dehmer, J.L. *Journal of Chemical Physics (USA),* 92(1): 262-274 (1 Jan 1990). DOE Contract W-31-109-ENG-38.

Two-color resonantly enhanced multiphoton ionization combined with photoelectron spectroscopy was used to study rotational autoionization of *np* Rydberg states of D_2 near the first ionization threshold. This work represents an extension of the study by O'Halloran *et al.* [J. Chem. Phys. **90**, 930 (1989)] on the analogous states of H_2. As in that work, one laser was used to excite a two-photon transition to the $E,F\ ^1\Sigma^+_g$, $v'=E0$, $J'=0$–4 levels, and a second laser was used to probe single-photon transitions to the rotationally autoionized *np* Rydberg states converging to the $X\ ^2\Sigma^+_g$, $v^+=0$, $N^+=1$–6 rotational levels of D^+_2. Of the five dipole-allowed Rydberg series converging to $v^+=0$ excited from each intermediate J' level ($J' \geq 2$), two are allowed to rotationally autoionize in a coupling scheme that assumes ejection of pure *p* waves in the ionization process and singlet coupling of the spins of the ion core and the outgoing electron; members of these Rydberg series have large half-widths. As in H_2, autoionization requiring the change of four quanta of rotational energy was found to be significantly slower than that requiring the minimum change of two quanta. Ionization was also observed for the series that are forbidden to rotationally autoionize according to this simple coupling scheme, and it is shown that both the inclusion of *f* waves in the autoionization process and singlet–triplet mixing may be required to explain these observations. By extending the wavelength region of the $J'=4$ spectrum beyond that of the earlier study on H_2, rotational autoionization requiring even higher partial waves was observed.

24865 Perturbation theory for strongly interacting atomic systems. Taulbjerg, K. (University of Tennessee, Knoxville, Tennessee 37996-1200 (USA)); Barrachina, R.O.; Macek, J.H. *Physical Review, A (General Physics) (USA),* 41(1): 207-219 (1 Jan 1990). DOE Contract AC05-84OR21400.

The strong-potential Born approximation has been formulated to include effects of elastic scattering in initial and final states. We use the standard distorted-wave theory and the eikonal approximation to derive closed-form expressions for scattering wave functions. Our results show that lowest-order theories must account for off-energy-shell electron propagation in the strong potential as well as for elastic scattering in initial and final states. Capture from inner shells and radiative electron capture are computed to illustrate the theory.

24866 Ba $6p_jnf_{l'}$ autoionizing series. Jones, R.R. (Department of Physics, University of Virginia, Charlottesville, Virginia 22901 (US)); Dai, C.J.; Gallagher, T.F. *Physical Review, A (General Physics) (USA),* 41(1): 316-326 (1 Jan 1990).

Members of the $6p_jnf_{l'}$ autoionizing series in barium have been observed experimentally using multistep laser excitation. The recorded spectra exhibit extremely broad profiles for *n* values ranging from 7 to 30. We have fitted the spectra using an energy-independent multichannel quantum-defect theory model that reproduces the data reasonably well in spite of the fact that the full widths at half maximum of the excitation profiles are comparable in magnitude to the energy spacings between adjacent states. Experimental quantum defects and autoionization rates are presented along with the parameters determined from the theoretical fit.

24867 Inversion of experimental data to generate state-to-state cross sections for rovibrationally inelastic scattering of CO_2 by hot hydrogen atoms. Kreutz, T.G. (Department of Chemistry and Columbia Radiation Laboratory, Columbia University, New York, New York 10027 (US)); Khan, F.A.; Flynn, G.W. *Journal of Chemical Physics (USA),* 92(1): 347-357 (1 Jan 1990).

State-to-state integral cross sections for rovibrationally inelastic collisions between CO_2 and hot hydrogen atoms are obtained by inversion of rotationally resolved population measurements of CO_2 (00^01). The inversion/fitting procedure is based upon the infinite order sudden (IOS) scaling law and employs a spline interpolating model to reduce the amount of information to be extracted. The experimental data used in the analysis was obtained using time domain tunable diode laser absorption spectroscopy to measure rotationally resolved excitation in CO_2 (00^01) following the generation of translationally hot H atoms via H_2S photolysis at 193 nm. The analysis utilizes data acquired at two temperatures, 292 and 223 K, in order to acquire additional information about the temperature independent scattering cross sections. Sensitivity analysis is employed to gauge the sensitivity of the extracted cross sections to uncertainties in the experimental data, and also to estimate the effect of additional measurements at different temperatures. The final extracted cross sections exhibit strong rotational inelasticity, with a propensity for scattering from 00^00; J' to both 00^01; $J=J'$ and 00^01; $J=|J'\pm41|$. The largest state-to-state collision cross section corresponds to the (00^00; $J'=0$) to (00^01; $J=41$) transition and has a magnitude of $(2.0\pm0.4)\times10^{-3}$ A^2.

24868 Muon-catalyzed fusion. Breunlich, W.H. (Institute for Medium Energy Physics, Austrian Academy of Sciences, Boltzmanngasse 3, A-1090 Vienna, (Austria)); Kammel, P.; Cohen, J.S.; Leon, M. *Annual Review of Nuclear and Particle Sciences (USA),* 39(1): 311-356 (1989).

Great progress achieved in muon-catalyzed fusion research in the past decade now makes it possible to review careful quantitative calculations and measurements. The major experimental surprises have doubled the fusion yields, but direct energy production would appear to be excluded without a significant breakthrough.(AIP)

24869 Comparative molecular-orbital and atomic-orbital study of electron transfer and excitation in He^++Na(3*s*) collisions at energies of 0.05 to 20 keV/amu. Fritsch, W. (Bereich Kern- und Strahlenphysik, Hahn-Meitner-Institut Berlin, D-1000 Berlin 39, West Germany (DE)); Kimura, M.; Lane, N.F. *Physical Review, A (General Physics) (USA),* 41(1): 508-511 (1 Jan 1990).

Electron transfer and excitation in 0.05- to 20-keV/amu He^++Na(3*s*) collisions is studied theoretically within the close-coupling method with two-electron molecular- and atomic-orbital expansion basis sets. Results agree with the trend of other information on this system. Remaining discrepancies that are larger than those in similar contemporary studies of one-electron systems are discussed with reference to the convergence of this two-electron study. Results for the integral alignment parameter A_{20} are also presented as a guideline for future experimental study.

24870 Near-100% production of the excited Be^+ $1s^22p$ ion from decay of Be $1s2s^22p$. Caldwell, C.D. (University of Central Florida, Orlando, Florida 32816 (USA)); Flemming, M.G.; Krause, M.O.; van der Meulen, P.; Pan, C.; Starace, A.F. *Physical Review, A (General Physics) (USA),* 41(1): 542-545 (1 Jan 1990). DOE Contract AC05-84OR21400.

In examining the decay of photon-produced Be $1s2s^2np(^1P)$, n=2,3, we discovered that the vastly predominant decay mode is to the final excited ionic states Be^+ $1s^2np$, rather than the ground state. For n=2, the 2*p* ion accounts for 95% of the total production, with Be^+ $1s^23p$ the other main contributor. For n=3, 3*p* is predominant, again with a very small fraction of 2*s*. The result for n=2 occurs as a consequence of the similarity between the 2*s* and 2*p* radial wave functions of the excited state, which leads to a cancellation in the amplitude for transition to the 2*s* ground state.

24871 Excitation-autoionization processes in electron-impact ionization of Au^{68+}. Reed, K.J. (High Temperature Physics Division, Lawrence Livermore National Laboratory, Livermore, California 94550 (USA)); Chen, M.H.; Moores, D.L. *Physical Review, A (General Physics) (USA),* 41(1): 550-553 (1 Jan 1990). DOE Contract W-7405-ENG-48.

Relativistic electron-impact ionization cross sections have been calculated for Au^{68+}. Direct ionization cross sections were computed using a relativistic distorted-wave method. Relativistic distorted-wave electron collisional excitation cross sections and detailed relativistic radiative and Auger rates were calculated in order to determine the contribution of excitation-autoionization processes. Because radiative channels are the predominant decay modes for highly charged heavy ions, the effects of excitation-autoionization processes were expected to be small for Au^{68+}. However, we found that these processes enhance the direct ionization cross sections by a factor of 4. This enhancement may be observed in experiments on the electron-beam ion trap in the near future.

24872 The production of vibrationally excited hydrogen molecules. Zhu, Y. (Department of Chemistry, University of Illinois at Chicago, Box 4348, Chicago, Illinois 60680 (US)); Huang, Y.; Arepalli, S.; Gordon, R.J. *Journal of Applied Physics (USA),* 67(2): 604-610 (15 Jan 1990).

The partial pressure of vibrationally excited hydrogen has been measured in a flowing gas using the technique of vacuum ultraviolet laser-induced fluorescence. In most of the studies H_2 (v=1) was generated with a microwave discharge. For this source we measured in detail the effects of the partial pressures of H_2 and Ar, the flow rate, the microwave power, and the construction of the flow tube. A more limited study was also performed using a thermally heated flow tube.

24873 Electron-beam propagation through a magnetic wiggler with random field errors. Esarey, E. (Beam Physics Branch, Plasma Physics Division, Naval Research Laboratory, Washington, D.C. 20375-5000 (USA)); Tang, C.; Marable, W. *Journal of Applied Physics (USA),* 67(5): 2210-2222 (1 Mar 1990).

The effects of random field errors on the propagation of a relativistic electron beam through a wiggler magnet are analyzed both theoretically and numerically. Both helical and planar wiggler configurations are studied, with and without the effects of transverse focusing forces. Theoretical expressions are derived for the random electron motion for (i) individual realizations of field errors and for (ii) ensembles of statistically identical wigglers. These results are then confirmed through three-dimensional particle simulations of electron-beam transport including the effects of finite emittance. In addition to producing a random walk of the beam centroid, the field errors lead to significant variations in the parallel beam energy. Asymptotically, the variance of the parallel beam energy scales as $z^{1/2}$, where z is the axial propagation distance. Although transverse beam focusing reduces the asymptotic scaling of the rms centroid displacement from $z^{3/2}$ to $z^{1/2}$, transverse focusing is not effective in reducing the parallel energy variation (the variance of the parallel beam energy is only reduced by a factor of $\sqrt{2}$). Statistically, the variance of the parallel beam energy may be interpreted as an effective parallel energy spread due to field errors. In order to maintain the wave–particle resonance in small-signal free-electron lasers, it is desirable for this effective energy spread to be small compared to the intrinsic efficiency. As an example, in the low-gain regime (assuming a helical wiggler in the strong-wiggler limit), this requirement implies that the normalized rms field error must satisfy $\delta\hat{B}_{rms} < 1/(2\pi N^{3/2})$, where N is the number of wiggler periods.

24874 Saturation effects in coherent anti-Stokes Raman scattering spectroscopy of hydrogen. Lucht, R.P. (Combustion Research Facility, Sandia National Laboratories, Livermore, California 94551 (US)); Farrow, R.L. *Journal of the Optical Society of America, Part B: Optical Physics (USA),* 6(12): 2313-2325 (Dec 1989).

Saturation of coherent anti-Stokes Raman scattering (CARS) spectra of the $Q(1)$ line of the hydrogen (1, 0) vibrational transition was investigated experimentally by using high-resolution lasers and theoretically by solving the time-dependent density matrix equations. The saturation behavior of hydrogen is complicated by the large Doppler width of the resonance and the high rate of velocity-changing collisions relative to dephasing collisions. Experimentally, CARS line shapes and saturation curves were measured in pure hydrogen at pressures of 100 and 3050 Torr. Surprisingly, the measured saturation intensity was found to be less at 3050 Torr than at 100 Torr. The time-dependent density matrix equations were numerically integrated to obtain CARS saturation curves and line shapes. Excellent agreement between calculated and experimental line shapes was obtained at both 100 and 3050 Torr, and the predicted saturation intensity was less at 3050 Torr than at 100 Torr. Based on the good agreement between theory and experiment obtained at 100 and 3050 Torr, the theoretical results were extended over a much wider pressure range, from 0.1 to 100,000 Torr. Below 1 Torr the saturation behavior is independent of pressure because collision times are long compared with times associated with laser excitation of the resonance, and the molecular response is completely transient. Between 1 and a few hundred Torr the saturation intensity increases as the rate of velocity-changing collisions increases. Above a few hundred Torr, however, the saturation intensity begins to decrease because the high rate of velocity-changing collisions ensures that all molecules couple effectively with the Raman-pumping lasers. Calculations show a minimum in saturation intensity at 2000 Torr. For even higher pressures, saturation is controlled by dephasing collisions, and the saturation intensity increases rapidly with pressure.

24875 Laser vaporization/rare gas matrix-isolation electron spin resonance studies of PdH^+_2, PdD^+_2, PdH, and PdD: Theoretical investigation of PdH^+_2. Knight, L.B. Jr. (Chemistry Department, Furman University, Greenville, South Carolina 29613 (USA)); Cobranchi, S.T.; Herlong, J.; Kirk, T.; Balasubramanian, K.; Das, K.K. *Journal of Chemical Physics (USA),* 92(5): 2721-2732 (1 Mar 1990).

The reactive laser vaporization of palladium metal in the presence of H_2(g) has been used to generate and trap neutral and charged palladium hydride radicals in neon and argon matrices for electron spin resonance investigations. The radicals identified are: $^0PdH^+_2$, $^{105}PdH^+_2$, $^0PdD^+_2$, $^{105}PdD^+_2$, ^0PdH, ^0PdD, ^{105}PdH, and ^{105}PdD. The electron spin resonance results prove that the H atoms are equivalent in PdH^+_2 but it cannot be determined for certain whether a highly bent $^2A_1$ ground state complex or a linear $^2\Sigma$ state is being observed, although the evidence seems to favor the $^2A_1$ state. The observed nuclear hyperfine properties (A and g tensors) are best accounted for by assigning the unpaired electron predominantly to $4d^2_z/5s$ orbitals on the metal in PdH^+_2 with only about 3% of the spin density on each H atom. Electron spin resonance results for PdH constitute the first observations for a diatomic metal hydride radical trapped in a neon matrix. The magnetic parameters (MHz) for $^{105}PdH^+_2$ in a neon matrix at 4 K are: $g_\perp$=2.568(2); $g_\parallel \cong 1.92$; $A_\perp(^{105}Pd) = -713(2)$; $A_\parallel(^{105}Pd) = -688(15)$;

$A_{\perp}$(H)=45(1). Multireference SCF (MCSCF) and configuration interaction (CI) calculations were conducted for PdH^{+}_{2} to calculate the energies and gross population distributions in the lowest-lying electronic states. The lowest of these, the $^{2}A_{1}$ state, has a calculated stabilization energy of 9.3 kcal/mol relative to $Pd^{+}(4d^{9})+H_{2}$.

24876 The effect of discretization on a path integral expression for the one-electron density. Hoffman, G.G. (Chemical and Laser Sciences Division, Los Alamos National Laboratories, Los Alamos, New Mexico 87545 (US)). *Journal of Chemical Physics (USA)*, 92(5): 2966-2973 (1 Mar 1990).

Using an integral expression which is based on the use of discretized path integrals, the one-particle density matrix is evaluated for individual fermions in a one- and three-dimensional harmonic well. In this regard, the present paper improves and extends work previously done by Handler. By deriving a closed form expression for the path integral with finite discretization, the density is expressed as a one-dimensional integral that can be evaluated numerically. In addition, the trace of this density matrix, which corresponds to the number of particles present as a function of the Fermi energy, is evaluated in closed form. For finite discretization, the function is continuous in the Fermi energy, but approaches the correct discontinuous limit as the discretization becomes large. Oscillations are observed at the discontinuities analogous to the Gibbs phenomenon of Fourier analysis. Calculations of the density show a marked improvement in the classically allowed region when the discretization is only one level beyond the simple Thomas–Fermi theory. The density also penetrates into the classically forbidden region as the discretization is increased, but the presence of negative oscillations requires a higher level of discretization for a proper description in this region.

24877 Continuous wave–continuous wave molecular double resonance spectroscopy: Lifetimes and term energies of individual rovibronic levels of the $(4p\pi)K\,^{2}\Pi(v=2)$ Rydberg state of nitric oxide. Miller, R.J. (Pacific Northwest Laboratory, P.O. Box 999, Richland, Washington 99352 (US)); Bushaw, B.A. *Journal of Chemical Physics (USA)*, 92(5): 3245-3247 (1 Mar 1990). DOE Contract AC06-76RL01830.

The $(4p\pi)K\,^{2}\Pi(v=2)\leftarrow(3s\sigma)A\,^{2}\Sigma^{+}(v=1)\leftarrow X^{2}\Pi(v=0)$ system of NO has been studied by (2+1) optical-optical double resonance laser induced fluorescence (LIF) dip techniques. These experiments utilized two high resolution, continuous-wave lasers. The spectral resolution obtained under these conditions has provided measurements of the frequencies to an absolute accuracy of better than 0.002 cm^{-1}, and of the widths to an average precision of 3% of the $K\leftarrow A(2,1)$ rotational transitions of interest. Term energies of individual rovibronic levels of both the Ω=0.5 and Ω=1.5 spin–orbit components of the $(4p\pi)K\,^{2}\Pi(v=2)$ Rydberg state of $^{14}N^{16}O$ have been determined. For values of J=2.5 to 4.5, the lifetimes of these levels range from 189 to 410 ps. These results demonstrate the potential of high resolution, cw lasers in double resonance studies of molecules. The ability to excite selectively to a *single, completely specified* quantum level, e.g., one hyperfine level, within the resonant intermediate state will ultimately allow studies of transition frequencies and lifetimes as functions of Ω, J, F, and parity providing a more explicit description of the structural and dynamical ramifications of complex multistate interactions.

24878 Muonium and positronium potentials. Gupta, S.N. (Department of Physics, Wayne State University, Detroit, Michigan 48202 (USA)); Repko, W.W.; Suchyta III, C.J. *Physical Review, D (Particles Fields) (USA)*, 40(12): 4100-4104 (15 Dec 1989).

Muonium and positronium potentials with radiative corrections are derived from the scattering operator, and general results for the spectra of these systems to order $\alpha^{3}R_{\infty}$ are obtained. We also compare our results with those obtained earlier with the Bethe-Salpeter approach, and find a discrepancy in the case of the 1S state. Our theoretical results are in good agreement with the available experimental data.

24879 Temperature rises produced by a molecular beam striking a Pt surface. Greene, E.F. (Brown Univ., Providence, RI (USA)); Tao, T.; Thantu, N. *Journal of Physical Chemistry (USA)*, 93(18): 6778-6785 (7 Sep 1989). DOE Contract FG02-85ER13441.

A platinum surface initially at room temperature is exposed to intense molecular beams of He, Ar, H_2, N_2, and SF_6 emerging from a nozzle also at room temperature. The mass of the platinum is small, so after a few minutes it reaches a steady temperature uniform throughout the sample. Because the rate of heat loss to the surroundings is low, a thermocouple records temperature rises that for pure gases are as much as 30 K and that for mixtures of He with Ar can exceed 100 K. Interpretation of the results shows that these rises can be understood quantitatively and thus provide information about energy transfer occurring when gaseous molecules collide with surfaces. In particular the method gives (1) a way of measuring the temperature T_s a surface attains at steady state due to interaction with gas molecules in the absence of heat conduction or radiation, (2) a simple determination of the average kinetic energy $E_i = 2k_BT_s$ of an incoming atomic beam without the need for measurement of the velocity distribution or the flux in the beam, and (3) a quantity γ that, like an energy accommodation coefficient, is a measure of the effect of the temperature of the surface on the scattering.

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Refer also to citation(s) 24024, 24102

24880 (UCID–21962) **A proposed experiment.** Latter, A.L.; Martinelli, E.A. Lawrence Livermore National Lab., CA (USA). Feb 1990. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008145. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In another report we described a device employing HE as an energy source to produce a wafer-like, 1 gram projectile, 2 cm in diameter, with a speed of 20 cm/μs. The device made use of three stages, the first of which had a velocity of ~0.3 cm/μs and a mass of ~38 kg. Each stage increased velocity by a factor of ~4. Much more detailed calculations are needed to validate the concept and to determine better values of the parameters, before a full-scale experiment can be justified. In the meantime, a relatively inexpensive, proof-of-principle experiment might be worthwhile. Instead of three stages with a velocity gain of four per stage, we could have a more modest goal of one stage with a velocity gain of three. To drive the device, we would use the 20 meter LLNL two-stage light-gas gun to produce a 47 g piston with a diameter of 28 mm and a speed of 0.6 cm/μs. The output mass would be a 2.04 g projectile with a diameter of 20 mm and a speed of 1.8 cm/μs. The kinetic-energy transfer efficiency would be in the neighborhood of fifty percent.

24881 Backward and forward stimulated Raman scattering from thin foil targets with a 0.26 μm laser. Labaune, C. (Laboratoire pour l'Utilisation des Lasers Intenses, Ecole Polytechnique, 91128 Palaiseau Cedex, France (FR)); Baldis, H.A.; Fabre, E.; Briand, F.; Villeneuve, D.M.; Estabrook, K. *Physics of Fluids B (USA)*, 2(1): 166-170 (Jan 1990).

Time-resolved spectra of backward and forward stimulated Raman scattering were measured from the interaction of 0.26 μm laser radiation with foil targets. The plastic foil targets were designed to go underdense before the peak of the 450 psec, 2×10^{15} W/cm^2 laser pulse. The Raman spectra were quite narrow at any one time ($\Delta\omega/\omega\sim0.05$) and shifted to shorter wavelengths during the pulse. The backward Raman spectra can be well predicted by assuming that the Raman occurs in a disk-shaped region on the top of the parabolic density profile, using well accepted threshold estimates.

24882 Stochastic backscatter in a subgrid-scale model: Plane shear mixing layer. Leith, C.E. (Center for Compressible Turbulence, Lawrence Livermore National Laboratory, Livermore, California 94550 (US)). *Physics of Fluids A (USA)*, 2(3): 297-299 (Mar 1990). DOE Contract W-7405-ENG-48.

The traditional Smagorinsky subgrid-scale viscosity $(C_S\lambda)^2S$ has been supplemented by the addition of stochastic backscatter. The random acceleration is derived from a vector potential $C_b|S\,\delta t|^{3/2}(\lambda/\delta t)^2g$. Here S is the local strain rate, λ is the grid resolution length scale, δt is the time step, and g is a unit random Gaussian. It is found that values C_S=0.2 for the Smagorinsky constant and C_b=0.4 for the backscatter constant give a robust calculation of the

two-dimensional shear mixing layer with the observed growth rate and with realistic emergence of random coherent eddy structures.

24883 Asymptotic limits of a statistical transport description. Malvagi, F. (School of Engineering and Applied Science, University of California, Los Angeles, Los Angeles, California 90024 (US)— Department of Mathematics, University of Arizona, Tucson, AZ 85721); Levermore, C.D.; Pomraning, G.C. *Transport Theory and Statistical Physics (USA),* 18(3): 287-311 (Jun 1989).

We consider three different asymptotic limits of a model describing linear particle transport in a stochastic medium consisting of two randomly mixed immiscible fluids. These three limits are: (1) the fluid packets are small compared to the particle mean free path in the packet; (2) a small amount of large cross section fluid is admixed with a large amount of small cross section fluid; and (3) the angular dependence of the intensity (angular flux) is nearly isotropic. The first two limits reduce the underlying model, which consists of two coupled transport equations, to a single transport equation of the usual form. The third limit yields a two-equation diffusion approximation, and a boundary layer analysis gives boundary conditions for these two coupled diffusion equations.

24884 Steady thermocapillary flows of thin liquid layers. I. Theory. Tan, M.J. (Reactor Analysis and Safety Division, Argonne National Laboratory, Argonne, Illinois 60439 (USA)); Bankoff, S.G.; Davis, S.H. *Physics of Fluids A (USA),* 2(3): 313-321 (Mar 1990). DOE Contract FG02-86ER13641.

A thin liquid layer rests on a horizontal plane that is subject to a two-dimensional spatially periodic temperature distribution. Thermocapillary forces on the free surface result in a dimpling interface and a steady viscous flow. Long-wave theory is used to study this system and to determine whether or not there is film dryout locally, and how such dimpling and/or dryout is affected by London–van der Waals forces, surface tension, and hydrostatic effects.

24885 Nonlinear interfacial stability of core-annular film flows. Papageorgiou, D.T. (The Levich Institute, City College of CUNY, 140th Street at Convent Avenue, New York, New York 10031 (USA)); Maldarelli, C.; Rumschitzki, D.S. *Physics of Fluids A (USA),* 2(3): 340-352 (Mar 1990).

In this paper the weakly nonlinear stability of two-phase core-annular film flows in the limit of small film thickness and in the presence of both viscosity stratification and interfacial tension is examined. Rational asymptotic expansions are used to derive some novel nonlinear evolution equations for the interface between the phases. The novel feature of the equations is that they include a coupling between core and film dynamics thus enabling a study of its effect on the nonlinear evolution of the interface. The nonlinear interfacial evolution is governed by modified Kuramoto–Sivashinsky equations in the cases of slow and moderate flow [the former also developed by Frenkel, *Sixth Symposium on Energy Engineering Sciences* (Argonne Lab. Pub. CONF-8805106, 1988), p.100, using different asymptotic methods], which include new nonlocal terms that reflect core dynamics. These equations are solved numerically for given initial conditions and a range of parameters. Some interesting behavior results, such as transition (in parameter space) of chaotic solutions into traveling-wave pulses with more than one characteristic length scale.

24886 Empirical and Stokes eigenfunctions and the far-dissipative turbulent spectrum. Foias, C. (Department of Mathematics, Indiana University, Bloomington, Indiana 47405 (USA)); Manley, O.; Sirovich, L. *Physics of Fluids A (USA),* 2(3): 464-467 (Mar 1990). DOE Contract FG02-86ER25020.

It is shown that the Stokes eigenfunctions and their corresponding spectra, frequently used in mathematical investigations of the Navier–Stokes equations, provide estimates on the spectrum of the two-point spatial covariance tensor. This, in turn, is used to estimate the far-dissipative turbulent spectrum. An exponential falloff is predicted and evidence given which implies that this is a sharp estimate.

24887 Computer simulations of finite plasmas convected across magnetized plasmas. Galvez, M. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (US)); Gisler, G.; Barnes, C. *Physics of Fluids B (USA),* 2(3): 516-522 (Mar 1990).

A two-dimensional electrostatic particle-in-cell code is used to simulate the convection of a plasma stream across a uniform magnetized plasma in the plane perpendicular to a given magnetic field **B**. These simulations show that the stream is convected by the **E**×**B** drift, where **E** is the electric field produced by polarization charge layers at the edges of the stream. The **E**×**B** velocity decreases as the background plasma density increases and with the distance traveled by the stream. This slowing of the stream is due to a short circuiting of the electric field by the background plasma within the stream that also polarizes and **E**×**B** drifts with the plasma stream. The simulations also show that the short circuiting of the electric field reduces the erosion of the plasma stream and the background plasma outside the stream is pushed away from the stream path by the fringe electric field.

24888 Comments on "Dynamics of decaying two-dimensional magnetohydrodynamic turbulence" [Phys. Fluids B 1, 1964 (1989)]. Diamond, P.H. (Department of Physics, University of California, San Diego, La Jolla, California 92093 (US)); Biskamp, D. *Physics of Fluids B (USA),* 2(3): 681-682 (Mar 1990).

In a recent simulation, Biskamp and Welter [Phys. Fluids B **1**, 1964 (1989)] noted that the dissipation scale in two-dimensional magnetohydrodynamic turbulence appears to be $l_d=(l_K\lambda)^{1/3}$, where l_K is the Kolmogorov dissipation scale and λ the Taylor microscale. Here, it is shown that this result can be obtained from a simple scaling argument, and is not a consequence of intermittency.

24889 Observation of an unstable k=1 diocotron mode on a hollow electron column. Driscoll, C.F. (University of California at San Diego, La Jolla, California 92093 (US)). *Physical Review Letters (USA),* 64(6): 645-648 (5 Feb 1990).

Stable and unstable diocotron modes varying as $e^{ik\theta}$, with k=1, are measured on a magnetized, partially hollow electron column. The unstable mode is observed to grow exponentially over several decades, in contradiction to present 2 D fluid theory. This k=1 instability can dominate the evolution well into the nonlinear regime, resulting in cross-field transport to a stable, monotonically decreasing density profile. To the extent this process is described by 2D **E**×**B** drifts, it is isomorphic to the Kelvin-Helmholtz shear-flow instability of inviscid fluids.

24890 Generation of strong MHD Alfvenic turbulence. Akimoto, K. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (US)); Winske, D. *Physical Review Letters (USA),* 64(7): 753-756 (12 Feb 1990).

Strong Alfvenic turbulence containing a number of solitonlike structures propagating at super-Alfvenic speeds is generated self-consistently and studied by means of computer simulation. A one-dimensional hybrid (kinetic ions, fluid electrons) code is used to investigate the nonlinear evolution of an electromagnetic ion-beam instability that generates low-frequency Alfven-like waves. As the instability develops, the field-aligned hydromagnetic waves steepen, forming a soliton that bifurcates several times, leading to a fully turbulent state.

24891 Stability of temporally periodic states of classical many-body systems. Bennett, C.H. (IBM Research Division, Thomas J. Watson Research Center, Yorktown Heights, New York 10598 (USA)); Grinstein, G.; He, Y.; Jayaprakash, C.; Mukamel, D. *Physical Review, A (General Physics) (USA),* 41(4): 1932-1935 (15 Feb 1990).

We study the stability of spatially coherent, time-periodic states in noisy, classical, discrete-time, many-body systems with short-range interactions. Generic stability of periodic k cycles with $k>2$ can be achieved only by rules carefully constructed to exploit lattice anisotropy and so suppress droplet growth. For ordinary rules which do not utilize spatial anisotropy in this way, periodic k cycles with periods $k>2$ are metastable rather than stable under generic conditions, losing spatial coherence through nucleation and growth of droplets. The unusual dynamical properties of the periodic states stabilized by anisotropy are described.

24892 Interaction of localized solutions for subcritical bifurcations. Brand, H.R. (Fachbereich 7 Physik-Universitaet Essen,

D-4300 Essen 1, West Germany (DE)—Center for Nonlinear Studies, MS-B 258, Los Alamos National Laboratory, University of California, Los Alamos, New Mexico 87545 (DE)); Deissler, R.J. *Physical Review Letters (USA)*, 63(26): 2801-2804 (25 Dec 1989).

We discuss the interaction of localized solutions as they arise for the subcritical bifurcation to traveling waves. We find that for a large parameter range the localized solutions can interact so that they emerge after the collision with a size and shape unchanged compared to that well before the collision. The mechanism for this behavior, which is unusual for a strongly dissipative system, is qualitatively different from that associated with solitons for completely integrable systems. In accord with this we find that for other parameter values counterpropagating localized solutions can annihilate.

6450 High Energy Physics

Refer also to citation(s) 24212

24893 (FNAL-TM–1636) **Providing a computing environment for a high energy physics workshop.** Andrews, C.; Butler, J.; Carter, T.; DeMar, P.; Fagan, D.; Gibbons, R.; Grigaliunas, V.; Haibeck, M.; Haring, P.; Horvath, C. Fermi National Accelerator Lab., Batavia, IL (USA). Dec 1989. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-890872–7: Workshop on physics at Fermilab in the 1990's, Breckenridge, CO (USA), 15-24 Aug 1989). Order Number DE90007905. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Although computing facilities have been provided at conferences and workshops remote from the host institution for some years, the equipment provided has rarely been capable of providing for much more than simple editing and electronic mail. This report documents the effort involved in providing a local computing facility with world-wide networking capability for a physics workshop so that we and others can benefit from the knowledge gained through the experience.

6451 Particle Interactions and Properties - Experimental

Refer also to citation(s) 24933, 24990

24894 (CEA-CONF–9905) **η (and π) production and decay at Saturne.** Mayer, B. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Nucleaire a Moyenne Energie. 1989. 7p. (CONF-8904233–: 3. international symposium on pion-nucleon and nucleon-nucleon physics, Leningrad (USSR), 22-27 Apr 1989). Order Number DE90762037. Available from NTIS (US Sales Only), PC A02/MF A01.

The search for rare (and forbidden) decay modes of light mesons like μ, π, K and η provides stringent tests of symmetries and conservation laws; they may also lead to hints of new interactions and particles. But while μ, π and K mesons are abundantly produced in various laboratories and their decay modes studied at the level of branching ratios of 10^{-12} and even lower, the data on η decays are scarce and very unprecise because until now η mesons were produced with low flux, essentially through the π^- p $\rightarrow$ n η reaction. Recent experiments at Saturne have shown a remarkably high production rate of η mesons in the pd $\rightarrow {}^3$He η reaction, with a very low level of background. This opens the possibility to study rare decay modes of the η with an η flux several orders of magnitude higher than in any previous experiment. Another advantage is that the η source is tagged. Pions are also produced abundantly in the dp $\rightarrow {}^3$He π^0 reaction, however we shall stress the η case since it is an original and rather unique possibility of the Saturne synchrotron. It is worth to recall here that the η meson is isoscalar while π is isovector, so that their decay modes bring complementary informations. In the first paragraph we give the main features of the source of tagged η for the Saturne synchrotron, then we discuss the Physics involved in the study of various decay modes of the η meson into charged particles and the last paragraph deals with the feasibility of such experiments.

24895 (DOE/ER/40291–6) **Unusual initial and final state effects in quantum chromodynamics: Progress report, July 15, 1989–February 20, 1990.** Nelson, C.A. State Univ. of New York, Binghamton, NY (USA). Dept. of Physics. Feb 1990. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER40291. Order Number DE90009014. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We have constructed fundamental tests which can be used to probe discrete symmetries, and their possible violations, in the required "new physics" beyond the standard model. In a recent paper for applications at an e^+e^- collider or a hadron collider, such as the SSC, we have proposed a number of tests using τ lepton and t quark polarimetry. Recently we have found that in measurements of electroweak couplings by $e^-e^+ \rightarrow \tau^-\tau^+$ at the Z^0, the ideal statistical errors can be significantly reduced by usage of spin correlation functions. This new technique appears very promising for high precision electroweak tests. In a separate research program, we are continuing to investigate our proposal that partons be identified with nearly degenerate, coherent quark-gluon "jet" states.

24896 (DOE/ER/40380–1) **HUGS [Hampton University Graduate Studies] at CEBAF [Continuous Electron Beam Accelerator Facility].** Southeastern Universities Research Association, Newport News, VA (USA). [1987]. 494p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER40380. Order Number DE90008286. Available from NTIS, PC A22/MF A01; OSTI; INIS.

This report discusses the following topics: hypernuclear physics with CEBAF emphasis; instructive aspects of few body systems; the three nucleon system: a review of lectures presented by Dr. J.L. Friar; special filter paper analyses and preliminary data derived therefrom; quarks and nuclear physics; perturbative QCD calculations of form factors; basic experimental instrumentation; electromagnetic interactions: the 'Super-Rosenbluth' decomposition; a longitudinal/transverse separation of the ^{12}C (e,e'p) reaction at quasielastic kinematics; and antiproton form factor from PQCD.

24897 (JINR-D–1-88-932) **Neutrinoproduction of charmed particles in hybrid experiment E-564.** Batusov, Yu.A. (and others); Bunyatov, S.A.; Kuznetsov, O.M. Collaboration the Fermilab E-564. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 22p. Order Number DE90620889. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Cryogenically sensitive nuclear emulsion was placed inside the 15-foot bubble chamber of FNAL and exposed to a wide-band energy (up to 200 GeV) neutrino beam. 194 charged-current neutrino interactions and 13 decays of charmed particles were registered. Using the nuclear emulsion as a vertex detector with a good spectrometric properties of the 15-foot bubble chamber has allowed the decays of charmed particles to be effectively analyzed. Attention is focussed on the new physical results: Λ_c^+ baryon and D_s^+ meson decay channels, production of charmed Σ_c baryons and Λ_c^+ via Σ_c. For the first time the event interpreted as production of the excited (cs-bar-state with mass $\approx$ 2790 MeV/c^2) has been registered. 31 refs.; 8 figs.; 1 tab.

24898 (JINR-E–1-88-476) **Evidence for higher twist mechanisms in high $p_{perpendicular}$ π^-p events with prompt ρ^0 production at 38 GeV/c.** Bannikov, A.V. (Joint Inst. for Nuclear Research, Dubna (USSR)); Boehm, J.; Grishkevich, Ya.V. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 9p. Order Number DE90620890. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to the 24. International conference on high energy physics, FRG, Muenchen, 1988.

The π^-p interactions with at least one charged secondary produced at polar angle of $\approx$ 90 deg in c.m.s. and having the transverse momentum above 1 GeV/c were invesigated. The data were obtained using streamer chamber magnetic spectrometer RISK at 38 GeV/c π^- beam from Serpukhov accelerator. The analysis of the associated production in reconstructed events suggests, that if the transverse momentum of pair of oppositely charged secondaries compensates the trigger particle $p_{perpendicular}$ practically completely, this pair is the product of the ρ^0-meson decay in marked fraction of such events. The probability of zero spin projection onto the normal to the ρ^0 production plane is equal to $\rho_{00}{}^T$=0.86$\pm$0.23. The enchancement of the number of events, in

which the ρ^0 picks up practically full momentum trsnafer carrying by the exchange, and also the enlarged tensor polarization for the ρ^0-mesons in these events, could be qualitatively explained as manifestation of direct ρ^0-production via the QCD higher twist processes in the high $p_{perpendicular}\pi^-p$ collisions. 11 refs.; 5 figs.; 1 tab.

24899 (JINR-E-1-88-651) **Possible interpretaion of a narrow resonance with a mass of 1960 MeV/c^2 observed at the CERN-SPS.** Amaglobeli, N.S. (Tbilisskij Gosudarstvennyj Univ., Tbilisi (USSR)); Dzhordzhadze, V.P.; Kekelidze, V.D.; Nikobadze, G.I.; Likhachev, M.F.; Lyubimov, A.L. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 6p. Order Number DE90620891. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to Z. Phys., C.

It is shown that a narrow state with a mass of 1960 MeV/c^2 decaying into Λ and K_s^0, which has been observed at the CERN-SPS in Ξ^-Be interactions and interpreted by the authors as a Ξ^{0*} resonance, is more likely to be a state with hidden strangeness $N_\Phi(1960)$ observed previously at the Serpukhov accelerator by means of the BIS-2 spectrometer. 4 refs.; 2 figs.; 3 tabs.

24900 (JINR-R-1-88-397) **Production of charmed baryons Λ_c^+ in np interactions at 40-70 GeV neutron energy.** Alaev, A.N. (and others); Aref'ev, V.A.; Balandin, V.P. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1988. 7p. (In Russian). Order Number DE90620892. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The production of charmed baryons Λ_c^+ decaying into K-bar deg $p\pi^+\pi^-$ and Λ deg $\pi^+\pi^+\pi^-$ has been observed. The inclusive cross sections times branching ratio for $x_F \geq 0.5$ and $P_T \leq 1$ GeV/c are $\sigma_p xB(\Lambda_c^+ \rightarrow K \text{ deg} p\pi^+\pi^-) = (1.0 \pm 0.3 \pm 0.2)\mu b$ and $\sigma_p xB(\Lambda_c^+ \rightarrow \Lambda \text{ deg } \pi^+\pi^-) = (0.28 \pm 0.15 \pm 0.04)\ \mu b$. From these values the partial width ratio $B(\Lambda_c^+ \rightarrow K\text{-bar deg } p\pi^+\pi^-)/B(\Lambda_c^+ \rightarrow \Lambda \text{ deg} \pi^+\pi^+\pi^-) = 3.5 \pm 2.2$ was estimated. The experiment has been performed in the neutron beam of the Serpukhov accelerator using the spectrometer BIS-2. 7 refs.; 5 figs.

24901 (JINR-R-1-88-796) **Measurement of analyzing power of elastic d ↑ p-scattering within the 2-12 GeV/c momentum range and in d ↑ C→pX reaction at 2.38 GeV/c momentum.** Avdejchikov, V.V. (Radievyj Inst., Leningrad (USSR)); Bogdanov, A.I.; Budilov, V.A. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1988. 11p. (In Russian). Order Number DE90620893. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The vector analyzing power in d↑C→pX reation is measured. For elastic processes the square range of transferred 4-momentum was $t = 0.005\text{-}0.054$ (GeV/c)^2. The protons from inelastic interaction were registered at 75 deg and 120 deg in the lab. system within the 40-300 MeV energy range. The measurements were performed on a polarized deuteron beam within the 2.36-12 GeV/c momentum range. 15 refs.; 6 figs.; 2 tabs.

24902 (UIUC-HEPG-90-42) **A search for $\nu_\mu \rightarrow \nu_e$ oscillations in a wide band neutrino beam.** Sullivan, G.W. Illinois Univ., Urbana, IL (USA). Dept. of Physics. 1990. 128p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76ER01195. Order Number DE90008867. Available from NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.

This is a report on a search for $\nu_\mu \rightarrow \nu_e$ oscillations using the E776 detector at Brookhaven National Laboratory. The detector consisted of a 226 metric ton electromagnetic calorimeter followed by a toroidal muon spectrometer and was located 1 km from the target at the AGS. 1.43×10^{19} protons on target were collected in the wide band beam with a peak neutrino energy of 1.1 GeV. No evidence for neutrino oscillations was observed. The 90% confidence limits obtained are $\Delta m^2 \leq 0.13$ eV^2 for large mixing angle, and $\sin^2 2\theta \leq 7.7 \times 10^{-3}$ in the limit of large Δm^2. 40 refs., 52 figs., 15 tabs.

24903 (UIUC-HEPG-90-44) **A study of D_s and D_s^* mesons.** Freese, T.J. Illinois Univ., Urbana, IL (USA). Dept. of Physics. 1990. 137p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76ER01195. Order Number DE90008868. Available from NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.

Hadronic decays of the D_s are studied in e^+e^- annihilation at center-of-mass energy 4.14 GeV/c^2. The data were collected with the Mark III detector at the storage ring SPEAR at the Stanford Linear Accelerator Center. The D_s mesons are produced predominantly in the reaction $e^+e^- \rightarrow D_s^{\pm}D_s^{*\mp}$, allowing measurement of the D_s and D_s^* masses. Measurements or upper limits of the cross section times branching fraction are presented for $D_s^+ \rightarrow \phi\pi^+$, $\bar{K}^{*0}K^+$, non-resonant $K^+K^-\pi^+$, $\phi\pi^+\pi^0$, $\phi\rho^+$, $\eta\pi^+$, $\omega\pi^+$, and $\eta'\pi^+$. The relative branching fraction for $D_s^+ \rightarrow \eta'\pi^+$ is significantly smaller than previous measurements. 75 refs., 69 figs., 8 tabs.

24904 **Observation of *B*-meson semileptonic decays to non-charmed final states.** Fulton, R.; Hempstead, M.; Jensen, T.; Johnson, D.R.; Kagan, H.; Kass, R.; Morrow, F.; Whitmore, J.; Wilson, P.; Chen, W. *Physical Review Letters (USA),* 64(1): 16-20 (1 Jan 1990).

We report the first evidence of charmless semileptonic decays of *B* mesons. In the momentum interval 2.4–2.6 GeV/*c* where the background from $b \rightarrow c l \nu$ is negligible, the average of the measured $b \rightarrow u e \nu$ and $b \rightarrow u \mu \nu$ partial branching ratios is $\Delta B_{ub}(2.4,2.6) = (1.8 \pm 0.4 \pm 0.3) \times 10^{-4}$. Inclusion of data from the interval 2.2–2.4 GeV/*c*, where the lepton yield is dominated by $b \rightarrow c l \nu$, gives $\Delta B_{ub}(2.2,2.6) = (3.3 \pm 0.8 \pm 0.8) \times 10^{-4}$. $|V_{ub}/V_{cb}|$ depends on the theoretical model of $b \rightarrow u l \nu$ decay and is approximately 0.1.

24905 **Search for the decay $K^+ \rightarrow \pi^+ \nu \bar{\nu}$.** Atiya, M.S. (Brookhaven National Laboratory, Upton, New York 11973 (USA)); Chiang, I.; Frank, J.S.; Haggerty, J.S.; Ito, M.M.; Kycia, T.F.; Li, K.K.; Littenberg, L.S.; Stevens, A.; Strand, R.C. *Physical Review Letters (USA),* 64(1): 21-24 (1 Jan 1990). DOE Contract AC02-76CH00016;W-7405-ENG-36;AC02-76ER03072.

An upper limit on the branching ratio for the decay $K^+ \rightarrow \pi^+ \nu \bar{\nu}$ is set at 3.4×10^{-8} (90% C.L.). In addition, a 90%-C.L. upper limit of 6.4×10^{-9} is set on the branching ratio for decays of the form $K^+ \rightarrow \pi^+ X^0$, where X^0 is any massless, weakly interacting neutral particle. Limits are also set for the case where $M_{X^0} > 0$.

24906 **Nuclear systems with strangeness.** Chrien, R.E. (Department of Physics, Brookhaven National Laboratory, Upton, New York 11973 (US)); Dover, C.B. *Annual Review of Nuclear and Particle Sciences (USA),* 39(1): 113-150 (1989).

Recent progress in hypernuclei research is reviewed. The contents discussed are hypernuclear production, hypernuclear structure, and weak decays of hypernuclei.(AIP)

24907 **Solar neutrinos.** Davis, R. Jr. (Department of Astronomy, University of Pennsylvania, Philadelphia, Pennsylvania 19104 (USA)); Mann, A.K.; Wolfenstein, L. *Annual Review of Nuclear and Particle Sciences (USA),* 39(1): 467-506 (1989).

The present experimental situation of the solar neutrino detection experiments is reviewed. The discrepancy between the predictions from the standard solar model and the experimental values persists. Two gallium detectors will soon be operational and new solar neutrino detectors are being proposed. A new determination to confront the theoretical predictions with empirical data beyond that obtained from the Chlorine 37 detector appears to have developed in the last few years.(AIP)

24908 **Rapidities of produced particles in 200-GeV/*c* π^+/p/K^+ interactions on Au, Ag, and Mg.** Brick, D.H. (Brown University, Providence, Rhode Island 02912 (USA)); Widgoff, M.; Beilliere, P.; Lutz, P.; Narjoux, J.L.; Gelfand, N.; Alyea, E.D. Jr.; Bloomer, M.; Bober, J.; Busza, W. *Physical Review, D (Particles Fields) (USA),* 41(3): 765-773 (1 Feb 1990).

We have used the Fermilab 30-in. bubble chamber–hybrid spectrometer to study the rapidities of "produced particles" in the interactions of 200-GeV/*c* protons and π^+ and K^+ mesons with nuclei of gold, silver, and magnesium. The average rapidity decreases linearly with the number of projectile collisions ν_p (up to $\nu_p = 5$) with no *A* dependence and little beam dependence. The ratio *R* of normalized rapidity distributions for hadron-nucleus to hadron-proton interactions shows a plateau in the central region, and becomes much larger in the target region. However, the increase is significantly less than has been reported in previous experiments. As a function of ν_p, the ratio *R* rises linearly in the target region, more gently in the central region, and decreases slowly in the projectile

region, in all cases with no *A* dependence. Some discrepancies with a previous experiment are observed in the central region. Long-range rapidity correlations are observed in hadron-nucleus events, but not in hadron-proton events. For the former, it is shown that the correlations exist only for those events with multiple projectile collisions, as expected in the multichain dual parton model.

24909 High-statistics measurement of g_a/g_v in $\Lambda \rightarrow p e^- \bar{\nu}$. Dworkin, J. (Department of Physics, University of Michigan, Ann Arbor, Michigan 48109 (USA)); Cox, P.T.; Dukes, E.C.; Overseth, O.E.; Handler, R.; Grobel, R.; Lundberg, B.; Pondrom, L.; Sheaff, M.; Wilkinson, C. *Physical Review, D (Particles Fields) (USA)*, 41(3): 780-800 (1 Feb 1990).

The analysis of 37 286 Λ β decays yields the axial-vector-to-vector coupling ratio $g_a(0)/g_v(0)=+0.731\pm0.016$, $\alpha_{ev}=-0.27\pm0.013$ with the weak-magnetism coupling $w=g_w(0)/g_v(0)=0.15\pm0.30$. The error is statistical only and there is no evidence for any significant systematic error. A new method is presented for resolving problems arising from the quadratic ambiguity in the analysis of this decay process. The q^2 dependence of the form factors has been included. Both the internal and external radiative corrections have been made. If w is constrained to be 0.97, the conserved-vector-current value, $g_a(0)/g_v(0)=+0.719\pm0.016\pm0.012$, where the uncertainties are statistical and systematic, respectively. The corresponding value of the electron-neutrino correlation is $\alpha_{ev}=-0.017\pm0.013\pm0.010$.

24910 Study of decays of the Λ_c^+. Anjos, J.C.; Appel, J.A.; Bean, A.; Bracker, S.B.; Browder, T.E.; Cremaldi, L.M.; Duboscq, J.E.; Elliot, J.R.; Escobar, C.O.; Estabrooks, P. *Physical Review, D (Particles Fields) (USA)*, 41(3): 801-804 (1 Feb 1990).

We report measurements of the decays $\Lambda_c^+ \rightarrow p\bar{K}^0$, $\Lambda_c^+ \rightarrow p\bar{K}^0\pi^+\pi^-$, $\Lambda_c^+ \rightarrow \Lambda^0\pi^+$, and $\Lambda_c^+ \rightarrow \Lambda^0\pi^+\pi^+\pi^-$ from Fermilab photoproduction experiment E691. We have measured the relative branching ratios $B(\Lambda_c^+ \rightarrow p\bar{K}^0)/B(\Lambda_c^+ \rightarrow pK^-\pi^+) = 0.55\pm0.17\pm0.14$, $B(\Lambda_c^+ \rightarrow \Lambda^0\pi^+\pi^+\pi^-)/B(\Lambda_c^+ \rightarrow pK^-\pi^+) = 0.82\pm0.29\pm0.27$, $B(\Lambda_c^+ \rightarrow \Lambda^0\pi^+)/B(\Lambda_c^+ \rightarrow pK^-\pi^+) < 0.33$ at 90% confidence level, and $B(\Lambda_c^+ \rightarrow p\bar{K}^0\pi^+\pi^-)/B(\Lambda_c^+ \rightarrow pK^-\pi^+) < 1.7$ at 90% confidence level.

24911 Measurement of the $\bar{p}p$ total cross section at $\sqrt{s}$=1.8 TeV. Amos, N.A.; Avila, C.; Baker, W.F.; Bertani, M.; Block, M.M.; Dimitroyannis, D.A.; Eartly, D.P.; Ellsworth, R.W.; Giacomelli, G.; Gomez, B. *Physical Review Letters (USA)*, 63(26): 2784-2786 (25 Dec 1989).

We have measured the antiproton-proton total cross section at $\sqrt{s}$ =1.8 TeV at the Fermilab Tevatron Collider; the value obtained is 78.3±5.9 mb. B, the nuclear slope parameter for elastic scattering, was measured to be 16.3±0.5 $(\mathrm{GeV}/c)^{-2}$. From these data, we derive a value for the total elastic cross section.

24912 Measurement of Z decays into lepton pairs. Abrams, G.S.; Adolphsen, C.E.; Averill, D.; Ballam, J.; Barish, B.C.; Barklow, T.; Barnett, B.A.; Bartelt, J.; Bethke, S.; Blockus, D. *Physical Review Letters (USA)*, 63(26): 2780-2783 (25 Dec 1989).

We present measurements by the Mark II experiment of the ratios of the leptonic partial widths of the Z boson to the hadronic partial width. The results are $\Gamma_{ee}/\Gamma_{had}=0.037_{-0.012}^{+0.016}$, $\Gamma_{\mu\mu}/\Gamma_{had\&s}=0.053_{-0.015}^{0.020}$, and $\Gamma_{\tau\tau}/\Gamma_{had}=0.066_{-0.017}^{+0.021}$, in good agreement with the standard-model prediction of 0.048. From the average leptonic width result, $\Gamma_{ll}/\Gamma_{had}=0.053_{-0.009}^{+0.010}$, we derive $\Gamma_{had}=1.56_{-0.24}^{+0.28}$ GeV. We find for the vector coupling constants of the tau and muon $v_\tau^2=0.31\pm0.31_{-0.30}^{+0.43}$ and $v_\mu^2=0.05\pm0.30_{-0.23}^{+0.34}$.

24913 Measurement of the $\Xi^0 \rightarrow \Sigma^0\gamma$ branching ratio and asymmetry parameter. Teige, S. (Department of Physics and Astronomy, Rutgers-The State University of New Jersey, Piscataway, New Jersey 08854 (USA)); Beretvas, A.; Caracappa, A.; Devlin, T.; Diehl, H.T.; Krueger, K.; Thomson, G.B.; Border, P.; Ho, P.M.; Longo, M.J. *Physical Review Letters (USA)*, 63(25): 2717-2720 (18 Dec 1989).

From 85±10 examples of the decay $\Xi^0 \rightarrow \Sigma^0\gamma$ we have measured the decay branching ratio $\Gamma(\Xi^0 \rightarrow \Sigma^0\gamma)/\Gamma(\Xi^0 \rightarrow \Lambda\pi^0) = [3.56\pm0.42(\mathrm{stat})\pm0.10(\mathrm{syst})]\times10^{-3}$ and the asymmetry parameter $\alpha(\Xi^0 \rightarrow \Sigma^0\gamma) = 0.20\pm0.32(\mathrm{stat})\pm0.05(\mathrm{syst})$.

6452 Particle Interactions and Properties - Theoretical

Refer also to citation(s) 24829, 24960, 24961, 24962, 24963, 24974, 24977, 25062

24914 (JINR-E-2-88-558) **Effective chiral lagrangians, the quark model of superconductivity type and the problem of P-A diagonalization.** Volkov, M.K. (Joint Inst. for Nuclear Research, Dubna (USSR)); Ivanov, A.N.; Troitskaya, N.I.; Nagy, M. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 23p. Order Number DE90620831. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to International journal of modern physics, A.

The vertices appearing after the inclusion of P-A transitions and a subsequent diagonalization of the chiral Lagrangian are analysed in the quark model of superconductivity type. These vertices can conditionally be divided into physical and nonphysical ones. It is shown that if the Pauli-Villars regularization is used, the contribution of the latter can be eliminated from the description of physical processes. This is in full agreement with experimental data. 23 refs.; 1 fig.

24915 (JINR-E-2-88-648) **Cosmic hadronization transition within the string-flip model of quark matter.** Voss, H. (Joint Inst. for Nuclear Research, Dubna (USSR)); Kaempfer, B.; Blaschke, D.; Roepke, G. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 12p. Order Number DE90620832. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Journal of Physics.

The equation of state for a massive quark matter phase is obtained within a string-flip model for the quark interaction. The hadronization transition is considered a finite temperature and vanishing baryon-chemical potential. The equation of state of the massive quark matter phase can be fairly well fitted by a bag model equation of state with $B_Q^{1/4} \approx 219$ MeV. From the latent heat and the critical pressure the time duration of the cosmic hadronisation transition is obtained in accordance with earlier estimates. 17 refs.; 4 figs.

24916 (JINR-E-2-88-717) **Asymptotics of the Altarelli-Parisi-Lipatov evolution kernels of parton distributions.** Korchemskij, G.P. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 20p. Order Number DE90620833. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The asymptotics of the evolution kernels $P_{ab}(z)$ of parton distributions is investigated as $z \rightarrow 1$. It is proved that to all orders of perturbative QCD the evolution kernels have one-loop asymptotics determined by the cusp anomalous dimensions of the contour functionals in the fundamental and abjoint representations of gauge group. A simple equation is found connecting the asymptotics of the evolution kernels in the lowest order of perturbation theory. 19 refs.; 2 figs.

24917 (JINR-E-2-88-793) **Description of inelastic nucleus-nucleus interactions at medium energies using dual parton model.** Polanski, A.; Shmakov, S.Yu.; Uzhinskij, V.V. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 20p. Order Number DE90620834. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

It is shown that the dual parton model, taking into account the processes of diffraction dissociation to the low-mass statesand finite energy corrections to the asymptotic Abramovski-Gribov-Kancheli cutting rules, allows satisfactory description of existing experimental data on hadron-nucleus and nucleus-nucleus interactions at medium energy. 26 refs.; 9 figs.; 4 tabs.

24918 (JINR-E-2-88-809) **Statistical clusters in multiparticle production.** Musulmanbekov, J.J. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation. 1988. 28p. Order Number DE90620835. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The possibility of describing multiparticle production in single-diffractive and non-single-diffractive interactions for pp and p-barp collisions is treated using the hypothesis of statistical cluster

emission. The description is valid under the following basic assumptions: (1)The cluster masses grow with collision energy. (2)The rapidity space occupied by clusters depends on inelasticity and collision energy. (3)The decay of clusters of masses $M_{cl} >> m_\pi$ is similar to the hadronization processes in e^+e^- annihilation. An account of the Monte-Carlo simulation model is given. It is shown that there is the changing of the behaviour of single-diffractive cross section in the energy region $\sqrt{s} \simeq$ 50-200 GeV. 43 refs., 22 figs.

24919 (JINR-E-2-88-840) **Determination of higher vector mesons from data on kaon electromagnetic form factors by means of the unitarized analytic VDM model.** Dubnicka, S. (Slovenska Akademia Vied, Bratislava (Czechoslovakia). Fyzikalny Ustav). Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 12p. Order Number DE90620836. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Unitarization of the VDM model isoscalar and isovector parts of kaon electromagnetic form factors is accomplished by incorporating analytic properties and nonzero values of vector meson widths in compatibility with the reality condition. The resultant model enables one to carry out a simultaneous fit of all the existing form factor data on charge and neutral kaons and to determine higher vector meson states in the $e^+e^- \to$KK-bar processes. In agreement with the results on the $e^+e^- \to \pi^+\pi^-$ analysis, the first radial excitations of ρ(770) meson at the mass value M_ρ=1315±183 MeV is revealed besides ϕ'(1680) in $e^+e^- \to$KK-bar. However, unlike the $e^+e^- \to \pi^+\pi^-$process the contribution of the ρ'(1250) resonance to $e^+e^- \to$KK-bar is favoured prior to the ρ"(1600) one by the experimental data. 25 refs.; 2 figs.

24920 (JINR-E-2-88-877) **The spin amplitude of high energy elastic NN-scattering in the case of strong form factors.** Goloskokov, S.V.; Kuleshov, S.P.; Selyugin, O.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 7p. Order Number DE90620837. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The spin-flip amplitude the elastic hadron scattering determined by the contribution of the nucleon and Δ_{33}-isobar in the intermediate state is calculated. The consideration of the strong form factors in the corresponding vertices and preasymptotic contributions in the meson-nucleon amplitude allowed us to correctly describe spin effects in pp-and pp high energy scattering without introducing the phenomenological parameter. 14 refs.; 2 figs.

24921 (JINR-E-2-88-915) **Quark-diquark approximation of the three-quark structure of a nucleon and the NN phase shifts.** Efimov, G.V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics); Ivanov, M.A.; Lyubovitskij, V.E. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 26p. Order Number DE90620838. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The quark-diquark approximations of the three-quark structure of a nucleon are considered in the framework of the quark confinement model (QCM) based on definite concepts of the hadronization and quark confinement. The static nucleon characteristics (magnetic moments, ratio G_A/G_V and strong meson-nucleon coupling constants) are calculated. The behaviour of the electromagnetic and strong nucleon form factors is obtained at the low energy ($0 \le Q^2 = -q^2 < 1 GeV^2$, where q is a transfer momentum). The one-boson exchange potential is constructed and the NN-phase-shifts are computed. Our results are compared with experiment and the Bonn potential model. 45 refs.; 7 figs.; 3 tabs.

24922 (JINR-E-4-88-536) **Partial restoraion of the chiral symmetry in the generalized Skyrme model.** Nikolaev, V.A. (Joint Inst. for Nuclear Research, Dubna (USSR)); Novozhilov, V.Yu.; Tkachev, O.G. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 4p. Order Number DE90620869. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to Pis'ma Zh. Ehksp. Teor. Fiz.

The improved Skyrme model that takes into account the main features of QCD (the formation of quark and gluon condensates due to the breaking of chiral and conformal symmetries) is considered. The effective potential for scalar mesons that was derived within the framework of the joint chiral and conformal bosonization method in QCD crucially defines the static properties of the topological solitons. The baryon observables improve considerably for the experimental value of the pion decay constant F_π in comparison with the original Skyrme model results. 4 refs.; 1 fig.; 1 tab.

24923 (JINR-R-2-88-560) **Bilocal meson lagrangians and potential model.** Kalinovskij, Yu.L. (Gomel'skij Politekhnicheskij Inst., Gomel (Byelorussian SSR)); Kallies, W.; Pervushin, V.N.; Kuranov, B.N.; Sarikov, N.A. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 15p. (In Russian). Order Number DE90620840. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The relativistic potential model is proposed for a unified description of spectroscopy and interactions of light and heavy quarkonia. The status of potential model in gauge theories and principle of construction of S-matrix with asymptotical bound states are discussed. Following these principles, anew three-dimensional relativistic equation for bound state wave functions is obtained, their normalization and meson interaction matrix elements are determined. A theorem connecting pion decay constant and quark vacuum expectation is proved. It is shown that bilocal Lagrangian describing meson interaction in a low energy limit coincides with the chiral Lagrangian. 20 refs.; 1 fig.

24924 (JINR-R-2-88-801) **Application of the quark-gluon string model and multiple scattering baryon model to calculation of hadron momentum spectra at 19.2 GeV/c.** Amelin, N.S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems); Ostrovidov, A.I. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 15p. (In Russian). Order Number DE90620841. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The Monte Carlo calculation of hadron-hadron interactions along with the planar, cylindrical and diffraction dissociation diagrams includes the diagrams representing preasymptotic corrections to interaction total cross sections as well. This permits to use the model at comparatively small energies. Hadron-nucleus interaction is considered as intranuclear cascade with hadron forming time considered. Satisfactory agreement with experimental data on double differential cross sections of hadron yield in pp and pA collisions is obtained. 12 refs.; 9 figs.; 1 tab.

24925 (JINR-R-2-88-828) **Phenomenological connections of the processes $\pi^- \to \nu$-bar$e\gamma$, $\pi^- \to \nu$-bar$e\gamma$, $a_1 \to \pi\rho$, $a_1 \to \pi\gamma$, $\pi^0 \to \gamma\gamma$.** Volkov, M.K. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 4p. (In Russian). Order Number DE90620817. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The estimate for the form-factor of a lepton pair e^+e^- in the $\pi^- \to \nu$-bar3e decay is obtained. This results follows from the condition of self-consistent phenomenological description of the processes $a_1 \to \pi\gamma$, $a_1 \to \pi\rho$ and $\pi^- \to \nu$-bar $e\gamma$. 11 refs.; 2 figs.

24926 (JINR-R-2-88-832) **Making allowance for recoil nucleon motion in chiral bag model.** Dorokhov, A.E. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics); Kanokov, Z.; Musakhanov, M.M.; Rakhimov, A. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 14p. (In Russian). Order Number DE90620842. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The role of recoil corrections in the process of pion scattering on nucleon is investigated within the framework of chiral bag model (CBM). Cases are considered when pions may get inside the bag and interact with quarks either on the bag surface (version1) or in its whole volume (version 2). It is shown that in CBM the consideration of recoil corrections in mNN-vertex is reduced to renormalization of f_πNN-interaction constant $f_\pi^{NN(ved)} = (1+1/MR) f_\pi^{NNstat}$, whose value is in better agreement with experiment than in statistical approximation. The contribution of recoil effects to the amplitude of πN/scattering is very much dependent on total momentum of the system, which is due to the action of the boost operator on spin variables. The contribution of recoil corrections to scattering lengths in the J=1/2 channel is found to be about 30% and in the J=3/2 it is insignificant. 13 refs.; 2 tabs.

24927 (JINR-R-2-88-888) **Spin-dependent structure functions of nucleon in the chiral bag model taking into account**

recoil effects. Dorokhov, A.E. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics); Kanokov, Z.; Rakhimov, A.M. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 8p. (In Russian). Order Number DE90620843. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Within the chiral bag model (CBM) the spin-dependent structure functions of a polarized proton $g_1^p(x)$ and polarized neutron $g_1^n(x)$ are investigated. The results obtained within CBM with a scalar πqq coupling agree with EMC experimental data rather well. 11 refs.; 1 fig.; 2 tabs.

24928 (JINR-R-4-88-708) **Pion photoproduction on nucleon in chiral bag model with taking into account the effects of recoil nucleon motion.** Dorokhov, A.E. (Joint Inst. for Nuclear Research, Dubna (USSR)); Kanokov, Z.; Musakhanov, M.M.; Rakhimov, A.M. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 15p. (In Russian). Order Number DE90620818. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Yad. Fiz.

The chiral bag model (CBM) is applied to study photoproduction on a nucleon. It is addumed that pions interact with quarks in the bag through a pseudoscalar coupling. Amplitudes of charged-pion photoproduction are found with taking into account the effects of nucleon recoil. The angular and energy distributions of charged pions, the polarization of recoil nucleon and the multipoles of the reaction are calculated. The nucleon recoil corrections to the static approximation are of the order of 10-15%. The results are in rather good agreement with experimental data at r_{bag}=1 fm. 13 refs.; 8 figs.

24929 (JINR-R-11-88-506) **Quarkonium in QCD with an increasing potential.** Amirkhanov, I.V. (Joint Inst. for Nuclear Research, Dubna (USSR)); Kallies, W.; Pervushin, V.N.; Puzynin, I.V.; Strizh, T.A.; Zhuraev, O.M.; Sarikov, N.A. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 12p. (In Russian). Order Number DE90620839. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The system of relativistic - covariant Schwinger - Dyson and Salpeter equations with an increasing potential is considered. The method for solving this system is proposed, and the numerical solutions for Schwinger - Dyson equations with oscillator potential by taking into account bare quark masses are obtained. 11 refs.; 2 figs.; 3 tabs.

24930 (LBL-28556) **W^+W^- interactions and the search for the Higgs boson.** Levi, M.E. Lawrence Berkeley Lab., CA (USA). Jul 1989. 97p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-8907134-7: 17. SLAC summer institute: physics at the 100 GeV mass scale, Stanford, CA (USA), 10-21 Jul 1989). Order Number DE90009218. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

Since the original paper by Peter Higgs in 1964, which was only a page and a half long, the number of publications on the topic of the Higgs particle has grown year by year and threatens to overwhelm us. If only for this reason it has become imperative that we find the Higgs. In this lecture series we will begin with a general review of the standard model Higgs and a summary of existing experimental limits on Higgs masses. We will then discuss Higgs searches at e^+e^- machines which are just coming on line, e.g. SLC and LEP, and proceed to work our way up to TLC, CLIC, and the SSC, where we will introduce the topic of W^+W^- interactions. The range of Higgs masses we cover will span six orders of magnitude from MeV to TeV. Non-minimal Higgs searches will not be dealt with in this lecture series; instead see the excellent theoretical reviews of both minimal and non-minimal model Higgs. 55 refs., 51 figs., 20 tabs.

24931 (RAL-89-114) **A Slater parameter optimisation interface for the CIV3 atomic structure code and its possible use with the R-matrix close coupling collision code.** Fawcett, B.C. (Rutherford Appleton Lab., Chilton (UK)); Hibbert, A. Rutherford Appleton Lab., Chilton (UK). Nov 1989. 19p. Order Number DE90620870. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Details are here provided of amendments to the atomic structure code CIV3 which allow the optional adjustment of Slater parameters and average energies of configurations so that they result in improved energy levels and eigenvectors. It is also indicated how, in principle, the resultant improved eigenvectors can be utilised by the R-matrix collision code, thus providing an optimised target for close coupling collision strength calculations. An analogous computational method was recently reported for distorted wave collision strength calculations and applied to Fe XIII. The general method is suitable for the computation of collision strengths for complex ions and in some cases can then provide a basis for collision strength calculations in ions where ab initio computations break down or result in unnecessarily large errors. (author).

24932 (UIUC-HEPG-90-36) **The threshold t-channel factorization model and its application to $\gamma\gamma$ reactions.** Alexander, G. (Tel Aviv Univ. (Israel). Dept. of Physics and Astronomy); Levy, A.; Maor, U. Illinois Univ., Urbana, IL (USA). Dept. of Physics. [1990]. 29p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76ER01195. (TAUP-1722-89). Order Number DE90008863. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The t-channel factorization model for threshold integrated cross sections is critically reviewed. Its applicability to $\gamma\gamma$ reactions is examined. It is argued that the model reproduces the enhancement observed in the diffractive channels of $\gamma\gamma \rightarrow$ 2 neutral vector mesons and reproduces the total $\gamma\gamma$ to hadrons cross section. 31 refs., 6 figs.

24933 (UIUC-HEPG-90-40) **Physics at the planck scale? A test of CPT invariance at Fermilab by experiment 773.** Gollin, G.D. Illinois Univ., Urbana, IL (USA). Dept. of Physics. [1989]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76ER01195. (CONF-8905219-3: Conference on CP violation in particle physics and astrophysics, Blois (France), 22-26 May 1989). Order Number DE90008866. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

It is possible that CPT-violating amplitudes with sizes of order m_K/m_{Planck} contribute to processes involving K mesons. We describe several tests of CPT invariance that could be carried out at Fermilab. One experiment in particular, E773, will perform a precision measurement of the phase difference between η_{00} and η_{+-} in 1990. Expected precision on $Arg(\eta_{00}) - Arg(\eta_{+-})$ is 0.5°. 9 refs., 2 figs.

24934 **Group theory approach to scattering. IV. Solvable potentials associated with SO(2,2).** Wu, J. (Center for Theoretical Physics, Sloane Laboratory, Yale University, New Haven, Connecticut 06511 (US)); Alhassid, Y.; Guersey, F. *Annals of Physics (New York) (USA),* 196(1): 163-181 (15 Nov 1989).

We use the potential group SO(2,2) to realize a class of solvable potentials. The scattering matrices can be obtained by purely algegraic techniques. © 1989 Academic Press, Inc.

24935 **Global existence in L^1 for the modified nonlinear Enskog equation in R^3.** Polewczak, J. (Virginia Polytechnic Institute and State Univ., Blacksburg (USA)). *Journal of Statistical Physics (USA),* 56(1-2): 159-173 (Jul 1989).

A global existence theorem with large initial data in L^1 is given for the modified Enskog equation in R^3. The method, which is based on the existence of a Liapunov functional (analog of the H-Boltzmann theorem), utilizes a weak compactness argument in L^1 in a similar way to the DiPerna-Lions proof for the Boltzmann equation. The existence theorem is obtained under certain condition on the behavior of the geometric factor Y. The condition on Y amounts to the fact that the L^1 norm of the collision term grows linearly when the local density tends to infinity.

24936 **Analyzing multiparticle reactions. I. Unitarizing perturbative amplitudes.** Klink, W.H. (Department of Physics and Astronomy, The University of Iowa, Iowa City, Iowa 52242 (US)). *Physical Review, C (Nuclear Physics) (USA),* 41(2): 435-441 (Feb 1990).

In order to analyze multiparticle reactions in which a small number of particles are created, it is necessary to ensure that model multiparticle amplitudes are properly unitarized. Multiparticle partial-wave amplitudes can be thought of as elements in a multiparticle

Hilbert space; it is shown how to modify the lengths of model partial-wave amplitudes so that they will satisfy inelastic unitarity conditions.

24937 Analyzing multiparticle reactions. II. Exactly solvable production models. Klink, W.H. (Department of Physics and Astronomy, The University of Iowa, Iowa City, Iowa 52242 (US)). *Physical Review, C (Nuclear Physics) (USA),* 41(2): 442-447 (Feb 1990).

A relativistic Lippmann-Schwinger equation for production reactions is developed. To obtain such equations a relativistic generalization of the Schroedinger and Lippmann-Schwinger equations is given, which, when applied to a Fock space appropriate for particles of mass m and zero spin, describes production reactions. Separable potentials are used for the production channels, which then incorporate the correct inelasticity in the elastic channel. Exact solutions to the relativistic Lippmann-Schwinger equations are given for potentials that are separable on all subspaces of the full Fock space.

24938 Small phases of nonminimal gauge models. Roy, P. (Department of Physics, University of Texas, Austin, Texas 78712 (US)). *Physical Review Letters (USA),* 64(7): 812 (12 Feb 1990).

A Comment on the Letter by S. Weinberg, Phys. Rev. Lett. 63, 2333 (1989).

24939 Four-weak-boson production at e^+e^- and pp supercolliders. Barger, V. (Physics Department, University of Wisconsin, Madison, Wisconsin 53706 (US)); Han, T.; Pi, H. *Physical Review, D (Particles Fields) (USA),* 41(3): 824-831 (1 Feb 1990).

We evaluate the cross sections for $W^+W^-W^+W^-$ and $ZZZZ$ production in e^+e^- and pp collisions. For four-W production, the predicted cross section is 0.7–1.8 fb at a $\sqrt{s}$ =2 TeV e^+e^- collider, and 6–23 fb at the Superconducting Super Collider, depending on the Higgs-boson mass. The Higgs-boson contributions to four-weak-boson production processes are more significant than in the case of three-weak-boson production and would enhance the above cross sections by about a factor of 4 if $m_H \sim 0.3$ TeV.

24940 Production of $W^\pm H^\mp$ from heavy-quark fusion. Dicus, D.A. (Center for Particle Theory, University of Texas at Austin, Austin, Texas 78712 (US)); Kao, C. *Physical Review, D (Particles Fields) (USA),* 41(3): 832-837 (1 Feb 1990).

The supersymmetric two-Higgs-doublet model is adopted to study the production of a charged Higgs boson ($H^\mp$) in association with a W boson ($W^\pm$) at future hadron colliders. The subprocess reactions $t\bar{t}\to W^\pm H^\mp$, $gt\to W^\pm H^\mp t$, $g\bar{t}\to W^\pm H^\mp \bar{t}$, and $gg\to W^\pm H^\mp t\bar{t}$ are combined to find the total rate.

24941 Hidden top quark with charged-Higgs-boson decay. Barger, V. (Physics Department, University of Wisconsin, Madison, Wisconsin 53706 (USA)); Phillips, R.J.N. *Physical Review, D (Particles Fields) (USA),* 41(3): 884-887 (1 Feb 1990).

In top-quark decays, there may be competition between decays mediated by real or virtual W bosons and decays into a charged Higgs boson. We evaluate the branching fractions to delineate the regions where standard top signals would be suppressed for two-Higgs-doublet models. We also show that both the standard semileptonic-decay signals $t\to bW^*\to bl\nu$ and unconventional signatures such as $t\to bH^*\to b\tau\nu$ may be simultaneously suppressed with suitable parameter choices for any top-quark mass; in such circumstances the top quark would be very difficult to detect at hadron colliders.

24942 Penguin-mediated exclusive hadronic weak B decays. Deshpande, N.G. (Institute of Theoretical Science, University of Oregon, Eugene, Oregon 97403 (USA)); Trampetic, J. *Physical Review, D (Particles Fields) (USA),* 41(3): 895-899 (1 Feb 1990).

We estimate a number of exclusive two-body charmless decays of B^+ and B^- mesons. Some of these are mediated predominantly through one-loop gluon exchange, while others have a comparable or larger contribution from the doubly Cabibbo-suppressed tree diagrams. The rates for several decays are in an observable range and should test the standard model.

24943 Dichotomy of leptons: Radiative masses and rare decays. Ma, E. (Department of Physics, University of California, Riverside, California 92521 (US)); Wong, G. *Physical Review, D (Particles Fields) (USA),* 41(3): 992-994 (1 Feb 1990).

A model is presented where the electron and muon masses are radiative and depend, respectively, on the masses of τ and a fourth charged lepton E. A discrete Z_4 symmetry is softly broken down to Z_2 which distinguishes (μ,τ) from (e,E). All three known neutrinos acquire radiative Majorana masses.

24944 Neutron electric dipole moment from charged-Higgs-boson exchange. Dicus, D.A. (Center for Particle Theory, Department of Physics, University of Texas, Austin, Texas 78712 (US)). *Physical Review, D (Particles Fields) (USA),* 41(3): 999-1000 (1 Feb 1990).

Weinberg has discovered a dimension-6 operator which makes a very large contribution to the neutron electric dipole moment through the exchange of a neutral Higgs boson. We show here that charged-Higgs-boson exchange, if it violates CP, can make an equally large contribution to the same operator.

24945 Some phenomenological aspects of the $SU(2)_q\times SU(2)_l\times U(1)_Y$ model. Barger, V. (Physics Department, University of Wisconsin, Madison, Wisconsin 53706 (USA)); Rizzo, T. *Physical Review, D (Particles Fields) (USA),* 41(3): 946-952 (1 Feb 1990). DOE Contract AC02-76ER00881.

We examine the implications of the recently proposed un-unified $SU(2)_q\times SU(2)_l\times U(1)_Y$ model for the extra-gauge-boson decay widths and hadronic production rates, the $e^+e^-\to\mu^+\mu^-$ and $\bar{p}p$ asymmetries, the B-meson semileptonic branching fraction, B^0-$\bar{B}^0$ mixing, and the CP-violating parameter ϵ. A perturbative requirement gives the bound $\sin\phi\gtrsim 0.22$ on the new mixing angle. Current searches at the Fermilab Tevatron collider for an extra Z boson can place a mass bound $M_{Z_H}\gtrsim 250$ GeV. The hadronic decays of W_H, Z_H produced in $\bar{p}p$ collisions may be observable as enhancements in the two-jet invariant-mass distribution. The enhanced low-energy nonleptonic interaction improves the agreement with experiment of the predicted B-meson semileptonic branching fraction.

24946 Theoretical implications of Fermilab Tevatron total and elastic differential-cross-section measurements. Block, M. (Department of Physics, Northwestern University, Evanston, Illinois 60208 (USA)); Fletcher, R.; Halzen, F.; Margolis, B.; Valin, P. *Physical Review, D (Particles Fields) (USA),* 41(3): 978-981 (1 Feb 1990).

Production of gluon jets becomes a feature of average hadron collisions for multi-TeV energies, leading to a model where interactions are mostly mediated by semihard gluons. We calculate forward scattering in this model as the shadow of the large inelastic cross sections associated with gluon jets. Using Fermilab Tevatron experiment E710 results, we deduce that ρ at 546 GeV is well below the central UA4 value of 0.24, defusing this number as a crucial issue.

24947 Estimate of exclusive B decays into charmonia and K and K^* mesons. Deshpande, N.G. (Institute of Theoretical Science, University of Oregon, Eugene, Oregon 97403 (USA)); Trampetic, J. *Physical Review, D (Particles Fields) (USA),* 41(3): 986-987 (1 Feb 1990).

We estimate the exclusive B decays $K\psi$, $K^*\psi$, $K\psi'$, and $K^*\psi'$ and find them in good agreement with recent experimental results.

24948 Identifying τ as a nonleptonic superparticle. Ma, E. (Department of Physics, University of California, Riverside, California 92521 (US)); Roy, P. *Physical Review, D (Particles Fields) (USA),* 41(3): 988-991 (1 Feb 1990).

Given a lepton number L=1 for e, ν_e, μ, and ν_μ, all available data at present are compatible with L=0 for τ and ν_τ. A model with such an assignment is shown to be as natural as the conventional one in a supersymmetric extension of the standard model. Processes such as $p\bar{p}$ (or pp)$\to\tau^\pm\tau^\pm$+ two quark jets as well as $ep\to\tau^-\tau^-$+ one quark jet+missing energy (p_T) provide unique signatures of this possibility.

24949 CP-violating correlations in electron-positron annihilation into τ leptons. Bernreuther, W. (Theoretical Physics Group, Physics Division, Lawrence Berkeley Laboratory, Berkeley, California 94720 (USA)); Nachtmann, O. *Physical Review Letters (USA),* 63(26): 2787-2790 (25 Dec 1989). DOE Contract AC03-76SF00098.

An analysis of *CP*-violating effects in $e^+e^- \to \tau^+\tau^-$ is outlined. Some tensor observables sensitive to *CP*-odd couplings arising from possible electric or weak dipole moments $d_\tau, \tilde{d}_\tau$ of the τ are presented. For the case where both τ's decay via $\tau \to \pi\nu_\tau$ we estimate the accuracies with which $\tilde{d}_\tau$ and d_τ can be measured at the *Z* resonance and at a τ-charm or *B* factory, respectively.

24950 Application of a generalized Feynman-Hellmann theorem to bound-state energy levels. Lichtenberg, D.B. (Department of Physics, Indiana University, Bloomington, Indiana 47405 (US)). *Physical Review, D (Particles Fields) (USA)*, 40(12): 4196-4198 (15 Dec 1989).

We derive a generalization of the Feynman-Hellmann theorem and use it to describe how the energy of a bound state changes with the change in mass of one of the constituent particles.

6453 Particle Invariance Principles and Symmetries

Refer also to citation(s) 24895, 24914, 24941, 24945, 24948, 24980, 24982, 24983, 24984, 24986

24951 (JINR-E-2-88-553) **A gauge model describing N relativistic particles bound by linear forces.** Filippov, A.T. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 14p. Order Number DE90620510. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Modern Physics Letters, A.

A relativistic model of N particles bound by linear forces is obtained by applying the gauging procedure to the linear canonical symmteries of a simple (rudimentary) nonrelativistic N-particle Lagrangian extended to relativistic phase space. The new (gauged) Lagrangian is formally Poincare invariant, the Hamiltonian is a linear combination of first-class constraints which are closed with respect to Pisson brackets and generate the localized canonical symmteries. The gauge potentials appear as the Lagrange multipliers of the constraints. Gauge fixing and quantization of the model are also briefly discussed. 11 refs.

24952 (JINR-E-2-88-607) **Neutralino production in polarized e^+e^--collisions.** Christova, E.Ch.; Nedelcheva, N.P. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 14p. Order Number DE90620511. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Nucl. Phys., B.

Annihilation of arbitrary polarized e^+e^- into two neutralinos χ_1 and χ_2 is considered in the framework of the minimal supersymmetric model. The cross section is calculated in the general case of neutralino mixing. The explicit dependence on the CP-particles of χ_i is obtained. It is shown that measurements of the umpolarized cross section and the spin asymmetries may distinguish between the following schemes of neutralino mixing: one produced neutralinos is either of higgsino or gaugino type or is a general mixture of higgsino and gaugino components. No assumptions about the other produced neutralino are made. If χ_1 is assumed to be the lightest SUSY particle, information about its type can be obtained. 16 refs.; 3 figs.; 1 tab.

24953 (JINR-E-2-88-658) **1+1 - d axial anomaly, Berry phase and induced charge, statistics and Wess-Zumino term.** Paranjape, M.B. (Montreal Univ., PQ (Canada). Lab. de Physique Nucleaire). Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 11p. Order Number DE90620512. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We consider 1+1-dimensional fermions interacting with gauge fields and a soliton field, through a chirally twisted mass term. This is a 1+1-dimensional analog of skyrmions interacting with fundamental fermions. We compute the Berry phase of the fermionic ground state for translations of the soliton, which is related to an induced Wess-Zumino term in the effective action. We also elucidate aspects of the axial anomaly and prove a non-existence theorem for the fractionization of fermion number. 8 refs.

24954 (JINR-E-2-88-670) **The Witten index for the supermembrane.** Pope, C.N. (University of Southern California, Los Angeles, CA (USA). Dept. of Physics); Stelle, K.S. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 10p. Order Number DE90620513. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The perturbative spectrum of the supermembrane in eleven-dimensional spacetime contains massless states as a consequence of the spacetime supersymmetry of the theory. We show, by defining a Witten index that has strictly positive value that supersymmetry remains unbroken non-perturbatively. 14 refs.

24955 (JINR-E-2-88-695) **Dynamical symmetry of a three-dimensional Wick-Cutkosky problem.** Matveev, V.A. (AN SSSR, Moscow (USSR). Inst. Yadernykh Issledovanij); Slepchenko, L.A.; Vardiashvili, M.D. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 10p. Order Number DE90620514. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The solutions of a three-dimensional Wick-Cutkosky problem are invesigated and the exact solution of this problem for the Coulomb quasipotential possessing the hidden 0(4)-symmetry is obtained. The conncetion of the general solution of three-dimensional Wick problem with the corresponding solution of the Bethe-Salpeter equation is considered. 7 refs.

24956 (JINR-E-2-88-701) **Green function of a three-dimensional Wick problem.** Matveev, V.A. (AN SSSR, Moscow (USSR). Inst. Yadernykh Issledovanij); Slepchenko, L.A.; Vardiashvili, M.D. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 10p. Order Number DE90620515. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

An exact solution of a three-dimensional Coulomb Wick-Cutkovsky problem has been obtained which possesses the hidden 0(4)-symmetry. Here we shell give the derivation of the corresponding Green function and consider its connection with the asymptoric behaviour of the scattering amplitude. 9 refs.

24957 (JINR-E-2-88-705) **Strings in arbitrary space-time dimensions.** Fabbrichesi, M.E.; Leviant, V.M. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 20p. Order Number DE90620516. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A modified approach to the theory of a quantum string is proposed. A discussion of the gauge fixing of conformal symmetry by means of Kac-Moody algebrae is presented. Virasoro-like operators are introduced to cancel the conformal anomaly in any number of space-time dimensions. The possibility of massless states in the spectrum is pointed out. 18 refs.

24958 (JINR-E-2-88-706) **Phase space in singular theories.** Gogilidze, S.A. (Tbilisskij Gosudarstvennyj Univ., Tbilisi (USSR)); Sanadze, V.V.; Tkebuchava, F.G.; Surovtsev, Yu.S. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 18p. Order Number DE90620517. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The method is formulated for constructing the generators of gauge transformations in the phase space for a given singular Lagrangian. These generators are used to impose necessary and sufficient conditions on gauge functions. The results are analysed for particular examples. 15 refs.

24959 (LRP-360/88) **Conservation laws and transport in Hamiltonian chaos.** Skiff, F. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Anderegg, F.; Good, T.N.; Paris, P.J.; Tran, M.Q.; Rynn, N.; Stern, R.A. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Nov 1988. 16p. Order Number DE90620518. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Experiments are presented which demonstrate the conservation of certain integrals of motion during Hamiltonian chaos where the conservation of some of the integrals has been broken by the overlap of resonances. Experimentally, conservation laws are demonstrated through the observation of restrictions on transport, in phase space, of chaotic trajectories. Transport of plasma ions during stochastic motion in an electrostatic wave is followed by means of laser induced fluorescence on metastable 'test particles' produced by optical pumping. (author) 5 figs., 8 refs.

24960 Asymmetric left-right model for generating radiative quark and lepton masses. Ma, E. (Department of Physics, University of California, Riverside, California 92521 (US)); Wong, G. *Physical Review, D (Particles Fields) (USA),* 41(3): 953-958 (1 Feb 1990).

The conventional $SU(2)_L \times SU(2)_R \times U(1)$ electroweak gauge model is extended to include two heavy singlet quarks and one heavy singlet lepton. The scalar sector consists of two (2,1,1/2) doublets, two (1,2,1/2) doublets, one (2,1,3/2) doublet, one (1,2,3/2) doublet, as well as one (1,3,1) triplet. Realistic radiative masses for all light quarks and leptons are obtained. A Z_2 discrete symmetry serves to distinguish the electron (or muon) and its neutrino from the other leptons.

24961 Alternative ununified standard model. Rajpoot, S. (Department of Physics, University of California, Riverside, California 92521 (US)). *Physical Review, D (Particles Fields) (USA),* 41(3): 995-996 (1 Feb 1990).

The $SU(2)_L{}^q \times SU(2)_L{}^l \times U(1)_Y$ gauge symmetry occurs as an intermediate stage in the descent of a more general class of electroweak interactions based on the gauge symmetry $G_{quarkmatter} \times G_{leptonicmatter}$. A three-family anomaly-free model based on the hybrid $SU(2)_L{}^q \times SU(2)_L{}^l \times U(1)_Y$ gauge interactions is presented in which all fermions acquire tree-level masses.

24962 Gluino-cascade-decay signatures at the Fermilab Tevatron collider. Baer, H. (Physics Department, Florida State University, Tallahassee, Florida 32306 (USA)); Tata, X.; Woodside, J. *Physical Review, D (Particles Fields) (USA),* 41(3): 906-915 (1 Feb 1990).

As the search for gluinos is extended to higher masses, the gluino cascade decays through lighter gaugino species can no longer be neglected. We compare gluino-cascade-decay signatures with signatures from direct gluino decay to the lightest supersymmetric particle assumed to be massless at the Fermilab Tevatron collider, assuming $m_{\tilde{g}} < m_{\tilde{q}}$. Cascade decays yield a softer missing-p_T (*p-slash*$_T$) spectrum which reduces the *p-slash*$_T$ cross section by a factor of 2–3 for $m_{\tilde{g}}$=100–150 GeV. However, new signatures characteristic of the cascade appear in the 0, 1, and 2 lepton plus jets plus p_T channels. We examine these signatures and compare with dominant standard-model backgrounds.

24963 Assignment of lepton numbers in supersymmetry. Ma, E. (Department of Physics, University of California, Riverside, California 92521 (US)); Ng, D. *Physical Review, D (Particles Fields) (USA),* 41(3): 1005-1007 (1 Feb 1990).

In a supersymmetric extension of the standard $SU(3) \times SU(2) \times U(1)$ gauge model of fundamental interactions, the assignment of lepton numbers to the color-singlet fermions is not unique. In addition to the conventional assignment, there are five other generically distinct scenarios, each with three possible variations. The existing experimental data constrain the values of various new couplings present in these models.

24964 Decoupling in supersymmetric gauge theories. Clark, T.E. (Department of Physics, Purdue University, West Lafayette, Indiana 47907 (US)); Love, S.T. *Physical Review, D (Particles Fields) (USA),* 40(12): 4117-4122 (15 Dec 1989).

The supersymmetric decoupling theorem is used to determine the low-energy effects of heavy-particle mass operators. This is achieved by exploiting the superconformal anomaly, as given by the trace of the supercurrent, in conjunction with renormalization-group techniques. The results are applied to the calculation of Higgs-boson and Higgsino decay amplitudes.

24965 Color distribution of confining electric flux in Abelian projection gauges. Greensite, J. (Physics and Astronomy Department, San Francisco State University, 1600 Holloway Avenue, San Francisco, California 94132 (USA)); Winchester, J. *Physical Review, D (Particles Fields) (USA),* 40(12): 4167-4170 (15 Dec 1989).

A numerical test is carried out on one of the predictions of 't Hooft's "Abelian projection" theory of quark confinement via monopole condensation. This theory predicts that in certain gauges the color-electric field $E_k{}^{ab}$ of a confining flux tube is diagonal in the color indices *ab*. Diagonality of the *E* field is tested by Monte Carlo simulation of SU(2) lattice gauge theory, using a field-strength gauge (F_{12} diagonal) proposed by 't Hooft, and also the "maximal Abelian gauge" of Kronfeld *et al.* In the field-strength gauge it is found that the color distribution of the confining electric field is completely random, while in the maximal Abelian gauge there is only a rather modest enhancement of the diagonal component above its random value, at coupling β=2.4. These data do not support the validity of the Abelian projection theory.

6454 Field Theory

Refer also to citation(s) 24833, 24937, 24960, 24964, 24965

24966 (DOE/ER/04915–4) **[Studies in quantum field theory]: Technical progress report, April 1, 1989–March 31, 1990.** Washington Univ., St. Louis, MO (USA). Dept. of Physics. [1990]. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-78ER04915. Order Number DE90008731. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

During the period 4/1/89–3/31/90 the theoretical physics group supported by Department of Energy Contract No. AC02-78ER04915.A015 and consisting of Professors Bender and Shrauner, Associate Professor Papanicolaou, Assistant Professor Ogilvie, and Senior Research Associate Visser has made progress in many areas of theoretical and mathematical physics. Professors Bender and Shrauner, Associate Professor Papanicolaou, Assistant Professor Ogilvie, and Research Associate Visser are currently conducting research in many areas of high energy theoretical and mathematical physics. These areas include: strong-coupling approximation; classical solutions of non-Abelian gauge theories; mean-field approximation in quantum field theory; path integral and coherent state representations in quantum field theory; lattice gauge calculations; the nature of perturbation theory in large order; quark condensation in QCD; chiral symmetry breaking; the 1/N expansion in quantum field theory; effective potential and action in quantum field theories, including OCD; studies of the early universe and inflation, and quantum gravity.

24967 (JINR-E–2-88-570) **Green-Schwarz superstring as an asymmetric chiral field sigma model.** Isaev, A.P.; Ivanov, E.A. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 18p. Order Number DE90620476. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A new class of two-dimensional σ-models of the Wess-Zumino-Witten type is constructed. The target manifold of these models is coset space GxG/G^-, where supergroup G is obtained by contraction from an arbitrary semisimple Lie supergroup and G^- is some abelian supergroup of translations in GxG. It is shown that the equations of motion following from the Wess-Zumino-Witten type action of these models admit a zero-curvature representation. 16 refs.

24968 (JINR-E–2-88-600) **Double logarithmic asymptotics in QCD.** Korchemskij, G.P. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 10p. Order Number DE90620477. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The infrared asymptotics of the quark electromagnetic form factor is investigated within the framework of perturbative QCD. The deep connection between the double logarithmic asymptotics in QCD and renormalization properties of contour functionals $< 0 —$ TPexp $(ig \int dz_\mu A^\mu(z)) — 0>$ is found. In particular, the quark electromagnetic form factor is calculated for massless quarks. It is shown that the nonleading logarithmic corrections to the form factor are summed up to give a decreasing exponential and they do not destroy the leading double logarithmic result. 18 refs.; 2 figs.

24969 (JINR-E–2-88-682) **On QED radiative corrections at HERA.** Bardin, D.Yu.; Burdik, C.; Cristova, P.Ch.; Riemann, T. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 10p. Order Number DE90620478. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

For the QED radiative corrections to the inclusive deep inelastic scattering process $ep \rightarrow eX$ at HERA energies complete analytic expressions are obtained and numerically presented. Photon- and

Z-boson exchange are included as well as soft photon exponentiation. 7 refs.; 1 fig.

24970 (JINR-E-2-88-783) **Gluon dynamics in QCD with increasing potential.** Bogolyubskaya, A.A. (Joint Inst. for Nuclear Research, Dubna (USSR)); Kallies, W.; Pervushin, V.N.; Kalinovskij, Yu.L. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 12p. Order Number DE90620479. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Phys. Lett., B.

The potential phenomenological experience of light quarks is generalized to gluons. Equations describing the glueball and gluon spectra are obtained and numerically solved. The proposed infrared modification of the QCD Hamiltonian by using an increasing potential leads to the perturbation theory with a small coupling constant in the low energy region and makes the potential model self-consistent with QCD. 8 refs.; 5 figs.

24971 (JINR-E-5-88-659) **Covariance operator of functional measure in $P(\phi)_2$-quantum field theory.** Lobanov, Yu.Yu.; Zhidkov, E.P. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 11p. Order Number DE90620480. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Functional integration measure in the Euclidean quantum field theory with polynomial interactions of boson fields with zero spin in two-dimensional space-time is investigated. The representation for the kernal of the measure covariance operator is obtained in the form of expansion over the eigenfunctions of some boundary problem for the heat equation. Two cases of the integration domains with different configurations are considered. Some trends and perspectives of employing the functional integration method in quantum field theory are also discussed. 43 refs.

24972 (JINR-R-2-88-769) **Some computer realizations of the REDUCE-3 calculations for exclusive processes.** Darbaidze, Ya.Z. (Tbilisskij Gosudarstvennyj Univ., Tbilisi (USSR)); Merebashvili, Z.V.; Rostovtsev, V.A. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation. 1988. 15p. (In Russian). Order Number DE90622151. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The REDUCE-3 algorithm for the calculation of the squared gauge invariant set of tree diagrams is given in the a^3 order of the perturbation theory. The necessity of using such program packages for factorization polynomials, group factor calculations and diagram and diagram generation is shown. The correctness of calculation for the infrared radiation corrections for Born parton cross sections as compared with manual calculations is discussed. An example of applying the programs for the matrix and noncommutative algebras when the well-known supersymmetric commutative relation is proved is presented. 35 refs.; 3 figs.

24973 (RAL-89-115) **Multiplicative renormalizability and self-consistent treatments of the Schwinger-Dyson equations.** Brown, N. (Rutherford Appleton Lab., Chilton (UK)); Dorey, N. Rutherford Appleton Lab., Chilton (UK). Nov 1989. 14p. (ED-89-476). Order Number DE90620481. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Many approximations to the Schwinger-Dyson equations place constraints on the renormalization constants of a theory. The requirement that the solutions to the equations be multiplicatively renormalizable also places constraints on these constants. Demanding that these two sets of constraints be compatible is an important test of the self-consistency of the approximations made. We illustrate this idea by considering the equation for the fermion propagator in massless quenched quantum electrodynamics, (QED), checking the consistency of various approximations. In particular, we show that the much used 'ladder' approximation is self-consistent, provided that the coupling constant is renormalized in a particular way. We also propose another approximation which satisfies this self-consistency test, but requires that the coupling be unrenormalized, as should be the case in the full quenched approximation. This new approximation admits an exact solution, which also satisfies the renormalization group equation for the quenched approximation. (author).

24974 **Lattice calculation of the kaon-matrix-element B parameter.** Kilcup, G.W. (Physics Department, Brown University, Providence, Rhode Island 02912 (USA)); Sharpe, S.R.; Gupta, R.; Patel, A. *Physical Review Letters (USA),* 64(1): 25-28 (1 Jan 1990).

We have calculated the kaon-matrix-element B parameter (B_K) using lattice QCD in the quenched approximation with staggered fermions. We find the correct chiral behavior. Errors from all sources except quenching are under control. At a lattice scale of 2 GeV our result is B_K=0.70±0.01(statistical)±0.03(systematic). This translates to a renormalization-group-invariant value $\hat{B}_K$=0.9–1.0.

24975 **Kinetic normal ordering and the Hamiltonian structure of $U(1)$ chiral anomalies in 3+1 dimensions.** Dunne, G.V. (Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (US)); Trugenberger, C.A. *Annals of Physics (New York) (USA),* 195(2): 356-375 (1 Nov 1989).

We present a fixed-time Hamiltonian derivation of the $U(1)$ chiral anomaly equation and the anomalous commutators of the vector and axial currents in 3+1 dimensions. Our computation is based on the physically correct normal ordering with respect to kinetic energy and shows that the only regularizations involved in the derivation of the chiral anomaly are kinetic normal ordering and a point-splitting regularization of the current operators. We obtain the standard results for the anomaly equation and the anomalous commutator $[\hat{\rho}, j_5^0]$; however, we obtain non-anomalous commutators for $[\hat{\rho}, j_5^i]$ and $[\hat{j}^i, j_5^0]$, in contrast to the BJL results. © 1989 Academic Press, Inc.

24976 **Flavor-changing Higgs-boson transitions.** Eilam, G. (Physics Department, Technion-Israel Institute of Technology, Haifa 32000, (Israel)); Haeri, B.; Soni, A. *Physical Review, D (Particles Fields) (USA),* 41(3): 875-883 (1 Feb 1990).

The flavor-changing Higgs-boson vertex $q_i q_j H$ where H is the Higgs boson and q_i, q_j are quarks with flavors i,j ($i \neq j$), respectively, is calculated in the standard model for all values of external and internal masses. It is then used to determine the $b' \to bH$ decay width, where b' is a charge $-(1/3)$ fourth-family quark. We find that for a range of masses the mode $b' \to bH$ can be very important and even be the dominant decay of the b'. If the fourth family exists, this decay may provide a way to detect the still elusive Higgs boson.

24977 **QCD β function with dynamical Wilson fermions.** Bitar, K. (Supercomputer Computations Research Institute, Florida State University, Tallahassee, Florida 32306-4052 (USA)); Kennedy, A.D.; Rossi, P. *Physical Review Letters (USA),* 63(25): 2713-2716 (18 Dec 1989).

We present data for the QCD β function with two flavors of light Wilson fermions. We use the hybrid Monte Carlo algorithm and the method of matching of ratios of products of Wilson loops. At β=6/g^2=6.0 perturbative scaling has not yet set in, whereas at β=6.8 it clearly has. Since the matching is done for the integral of the β function this scaling is expected above β=6.0.

24978 **Quantum mechanics of exponential-potential inflation.** Ratra, B. (Joseph Henry Laboratories, Department of Physics, Princeton University, Princeton, New Jersey 08544 (US)). *Physical Review, D (Particles Fields) (USA),* 40(12): 3939-3949 (15 Dec 1989).

A spatially flat cosmological scalar field ϕ model with an exponential scalar field potential $V(\phi) \propto \exp(-\phi/\sqrt{p})$, with $p>1$, has a time-dependent fixed-point solution which describes an inflating universe with the scale factor evolving as $a(t) \propto t^p$. In the limit $p \to \infty$ this model reduces to the usual exponential expansion inflation model. In this paper we derive the inflationary epoch spectra of energy density and gravitational-wave irregularities by perturbatively solving the quantum-mechanical Dirac-Wheeler-DeWitt equations for this model. Our results agree with those found using an essentially classical analysis. We also show, by using two different orderings of factors in the quantum-mechanical Hamiltonian, that operator-ordering ambiguities do not affect the spectrum of irregularities to the order to which we work; they do, however, affect the normalization of the wave function.

24979 Solvable two-dimensional models and the Virasoro algebra. Tanaka, K. (Department of Physics, The Ohio State University, Columbus, Ohio 43210 (US)). *Physical Review, D (Particles Fields) (USA),* 40(12): 4092-4095 (15 Dec 1989).

The Poisson brackets of various solvable two-dimensional models are specified by the Virasoro algebra. As a result, their equations of motion result from appropriate evolution equations. These models share an infinite number of conserved quantities and the same central charge and are related by suitable changes of dynamical variables. In the quantum version, the conserved quantities are modified differently but the central charge is common.

24980 BRST quantization of the superstring in background fields. Das, A. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627 (USA)); Maharana, J.; Roy, S. *Physical Review, D (Particles Fields) (USA),* 40(12): 4037-4046 (15 Dec 1989). DOE Contract AC02-76ER13065.

We study the superconformal algebra of the Neveu-Schwarz-Ramond superstring in the background of graviton and antisymmetric tensor fields. The classical Becchi-Rouet-Stora-Tyutin charge is obtained and the gravitational Ward identities are presented using the invariance properties of the *S*-matrix generating functional.

24981 Modular invariance and stochastic quantization. Ordonez, C.R. (Theory Group, Rockefeller University, New York, New York 10021 (USA)); Rubin, M.A.; Zwanziger, D. *Physical Review, D (Particles Fields) (USA),* 40(12): 4056-4072 (15 Dec 1989).

In Polyakov path integrals and covariant closed-string field theory, integration over Teichmueller parameters must be restricted by hand to a single modular region. This problem has an analog in Yang-Mills gauge theory—namely, the Gribov problem, which can be resolved by the method of stochastic gauge fixing. This method is here employed to quantize a simple modular-invariant system: the Polyakov point particle. In the limit of a large gauge-fixing force, it is shown that suitable choices for the functional form of the gauge-fixing force can lead to a restriction of Teichmueller integration to a single modular region. Modifications which arise when applying stochastic quantization to a system in which the volume of the orbits of the gauge group depends on a dynamical variable, such as a Teichmueller parameter, are pointed out, and the extension to Polyakov strings and covariant closed-string field theory is discussed.

24982 Supersymmetric open strings in fewer than ten dimensions. Clavelli, L. (Department of Physics and Astronomy, University of Alabama, Tuscaloosa, Alabama 35487 (USA)); Cox, P.H.; Elmfors, P.; Harms, B. *Physical Review, D (Particles Fields) (USA),* 40(12): 4078-4084 (15 Dec 1989).

We discuss the reduction of the critical dimension of open strings in the fermionic construction. Requiring the preservation of supersymmetry and finiteness, we find one consistent type-I theory with a minimal number of sectors in each of the space-time dimensions 9, 7, 6, 5, 3, and 2. Each of these is "mixed" in that there are sectors containing both Neveu-Schwarz and Ramond fields. No consistent open-string solution of this type is found for $D=4$.

24983 Dynamical symmetry breaking from toroidal compactification. Hetrick, J.E. (School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455 (USA)); Ho, C. *Physical Review, D (Particles Fields) (USA),* 40(12): 4085-4091 (15 Dec 1989).

We derive the one-loop effective potential for the vacuum expectation values of the toroidal gauge field components where the spacetime is $(d-n)$-dimensional Minkowski space times an n-dimensional torus. The minima of this potential determine the gauge group holonomy over the torus and subsequently the symmetry-breaking pattern. We analyze in detail this behavior for the group SU(2) on $R^{1,1}\times T^2$ as the boundary conditions of the fermions and the lengths of the toroidal circumferences vary.

24984 Topologically nontrivial solutions to Yang-Mills equations with axisymmetric external sources. Isidro Filho, M.P. (Center for Theoretical Physics, Laboratory for Nuclear Science dge, Massachusetts 02139 (US)); Kerman, A.K.; Trottier, H.D. *Physical Review, D (Particles Fields) (USA),* 40(12): 4142-4150 (15 Dec 1989).

We present a new set of solutions to Yang-Mills equations with axially symmetric external charge sources. Our solutions for the gauge fields are not explicitly axisymmetric, but the noninvariance of the fields under a rotation about the symmetry axis can be compensated by a gauge transformation about a symmetry axis in gauge space. All gauge-invariant quantities are therefore axisymmetric. Our solutions are characterized by a gauge-invariant integer winding number n, and all winding numbers are allowed. We prove that the total gauge-invariant charge of the system (source plus gauge fields) vanishes identically in our solutions for $n\neq 0$, even if the source has net charge. We explicitly solve the equations of motion for a spherical shell of charge. The solution depends on the gauge coupling g, the total charge of the shell Q_S, and the topological number n. We use perturbative methods to obtain the solution in closed form for $\tilde{\alpha}=g^2Q_S/(4\pi)\ll 1$. We show analytically that in this limit the energy $scrE_n$ of the system satisfies the bound $scrE_n\leq[g^2{Q_S}^2/(8\pi a)]\times 1/(2+1)$, where a is the radius of the shell. Using relaxation methods to find the exact solution to the equations of motion numerically for arbitrary $\tilde{\alpha}$, we establish that this bound is satisfied for all g, Q_S, and n.

24985 Fermion self-energy corrections in perturbative theory at finite temperature. Altherr, T. (Laboratoire d'Annecy-le-Vieux de Physique des Particules, Institut National de Physique Nucleaire et de Physique des Particules, Boite Postale No. 110, 74941 Annecy-le-Vieux CEDEX, France (FR)); Aurenche, P. *Physical Review, D (Particles Fields) (USA),* 40(12): 4171-4177 (15 Dec 1989).

We discuss various aspects of self-energy corrections to the fermion propagator at a finite temperature. Several calculational methods not relying on the renormalization of the mass or of the wave function are discussed. General expressions are given. It is shown that, when calculating a physical process, the thermal mass enters essentially the phase-space factor and not the dynamical part of the process, at least in some limiting cases. Comparison with the renormalization approach is discussed and it appears that there are no ambiguities in the calculation of the self-energy corrections at finite temperature.

24986 Possible avoidance of a no-go theorem for glueballs in an effective-action model of QCD. Mendel, R.R. (Department of Applied Mathematics, The University of Western Ontario, London, Ontario, Canada N6A 5B9 (CA)); Trottier, H.D. *Physical Review, D (Particles Fields) (USA),* 40(12): 4193-4195 (15 Dec 1989).

Sum rules are derived from a variational method applied to a renormalization-group-improved effective action of QCD. These sum rules extend an earlier no-go theorem for static glueball solutions in three spatial dimensions, but indicate that the recently proposed possibility of a finite discontinuity in the nonlinear dielectric function may be a viable way of avoiding this no-go theorem. However, these sum rules preclude the possibility of "purely electric" ($\mathbf{B}^a=0$) solutions.

65 PHYSICS II

6510 Nuclear Physics

Refer also to citation(s) 23562, 24897

24987 (BNL-NCS–51771-Ed.1-Suppl.5) **Integral charged particle nuclear data bibliography: Literature scanned from November 11, 1988 through November 30, 1989: First edition, Supplement 5.** Holden, N.E.; Ramavataram, S. Brookhaven National Lab., Upton, NY (USA). Dec 1989. 29p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC02-76CH00016. Order Number DE90008151. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This publication is the annual supplement to the first edition published in 1984. The primary goal of this publication has been to satisfy the need expressed by the Nuclear Reaction Data Center Network for a concise and comprehensive bibliography of integral

charged–particle cross section data. Included in this paper is a partial list of other bibliographies relevant to charged-particle-induced reaction data and a source list of nuclear data bibliographies, complications, and cumulative, earlier versions are also shown in the tables. This publication makes use of a modification to the database of the Nuclear Structure References (NSR) file. This modification allows the retrieval of integral charged particle nuclear data entries from the NSR file. In recent years, the presentation of various sections was changed, as a result of users' suggestions. The authors continue to welcome users' comments.

24988 (JINR-E–6-88-578) **Systematics of the 1^+ states in doubly odd nuclei of La and Pr.** Mikhajlova, M.M. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 13p. Order Number DE90620955. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Experimental results of the investigation of the 1^+ states excited by β-decay in La and Pr nuclei together with the data for higher energy states, obtained in nuclear reaction studies, are presented and discussed. The possibility of representing these states as superpositions in nighbouring odd nuclei excitations is noted and briefly analyzed by using previous calculations for the corresponding odd nuclei. 56 refs.; 6 figs.

24989 (JINR-R–1-88-406) **Size of π^--meson emission region in inelastic and central nuclear-nuclear interactions at E_p=3.66 A GeV.** Abdurakhimov, A.U. (and others); Anikina, M.Kh.; Vardenga, G.L. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1988. 3p. (In Russian). Order Number DE90620956. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The size of secondary π^--mesons origin was estimated on the basis of correlation analysis of identical pions created in central and inelastic interactions of ^{4}He, ^{12}C, ^{16}O nuclei with Li,C,Ne,Cu nuclei at 3.66 AxGeV energy. No difference above errors was observed between the obtained values and the results of corresponding experiments with relativistic nuclei at lower energies. 9 refs.; 1 fig.; 1 tab.

24990 (JINR-R–1-88-821) **Investigation of Δ^{++}(1232) isobar production in light nucleus (p,d,^{4}He,^{12}C) interactions with carbon and hydrogen nuclei at 4.2 GeV/c per nucleon momentum.** Grishin, V.G. (and others); Didenko, L.A.; Ivanovskaya, I.A. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1988. 10p. (In Russian). Order Number DE90620957. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The experimntal data have been obtained using of the 2-meter propane bubble chamber of JINR irradiated by proton, deuteron, helium and carbon beams with 4.2 GeV/c momentum per nucleon. This work and studied experimntal data are the part a large relativistic nucleus-nuclear collision research program realized by 2-m propane bubble chamber collaboration. Interactions of beam particles with propane were analyzed. The data on protons and π-mesons were used to calculate effective mass spectra ($p\pi^+$). These spectra were compared with effective mass spectra ($p\pi^+$) obtained in pp-interactions for the same momentum. The performed analysis leads to the conclusion that the mechanism of π production in light nucleus interactions at 4.2 GeV/c per nucleon is similar to the mechanism of π-prodction in pp-interactions in which not less than 50% of all π mesons is producted through Δ-resonance. 6 refs.; 10 figs.

6512 Nuclear Properties and Reactions, A = 1-5, Experimental

24991 (JAERI-M–90-024) **Evaluation of neutron nuclear data for ^{3}He and ^{4}He.** Shibata, Keiichi. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1990. 34p. (NEANDC(J)–148/U;INDC(JPN)–135/L). Available from Japan Atomic Energy Research Institute, Dept. of Technical Information, Tokai-mura, Naka-gun, Ibaraki-ken 319-11, Japan.

Neutron-induced cross sections of ^{3}He and ^{4}He have been evaluated for JENDL-3 in the energy range from 10^{-5} eV to 20 MeV. Evaluated quantities are the total and elastic scattering cross sections of ^{4}He and the total, elastic scattering, (n,p) and (n,d) reaction cross sections of ^{3}He. The total and elastic scattering cross sections of ^{4}He were analyzed with the R-matrix theory in the overall energy region. In the ^{3}He evaluation, the R-matrix calculation was performed below 1 MeV by considering the total, elastic scattering and (n,p) reaction cross sections, and above 1 MeV the evaluation was based on available experimental data. The evaluated data have been compiled in the ENDF-5 format. 33 refs., 25 figs., 3 tabs.

24992 (JINR-D–1-88-691) **Production and decay of relativistic hydrogen hypernuclei.** Avramenko, S.A. (and others); Abdurakhimov, A.U.; Aksinenko, V.D. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 3p. Order Number DE90620962. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Relativistic hypernuclei are registered with unambigous identification for the first time. The production cross section of $_\Lambda{}^4$H on a CH_2 target with a ^{4}He beam at 18 GeV/c is 0.4+0.4 μb, 0.4-0.2 μb. The mean momentum and mean lifetime are (16.7$\pm$0.2) GeV/c and (2.2+0.5, 2.2-0.4)x10^{-10} s respectively. 15 refs.

24993 (JINR-R–1-88-503) **Study on dibaryon states in dp-interactions at 3.33 GeV/c momentum.** Balgansuren, Ya. (Joint Inst. for Nuclear Research, Dubna (USSR)); Buzdavina, N.A.; Glagolev, V.V. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 10p. (In Russian). Order Number DE90620963. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The experiment was performed using the H.E.L., JINR hydrogen bubble chamber. d(d↑)p interactions at 3.33 GeV/c momentum were studied. Criteria for determination of the kinematical region for the optimal observation of dibaryon states are proposed. Effective mass distributions of two nucleons are presented. The observed maxima are in agreement with theoretical predictions of dibaryon resonances. 32 refs.; 9 figs.; 2 tabs.

24994 Forward-angle charged-pion electroproduction in the deuteron. Gilman, R.; Bernheim, M.; Brussel, M.; Cheminaud, J.; Danel, J.; Didelez, J.; Duval, M.; Fournier, G.; Frascaria, R.; Holt, R.J. *Physical Review Letters (USA)*, 64(6): 622-624 (5 Feb 1990). DOE Contract W-31-109-ENG-38.

A direct experimental determination has been made of the ratio of the forward-angle positive-pion electroproduction cross section for a proton bound in the deuteron with that of a free proton for invariant masses of 1160 and 1232 MeV. A significant quenching of the reaction in the deuteron is observed.

24995 Measurement of the ^{3}He(n,γ)^{4}He cross section at thermal neutron energies. Wolfs, F.L.H. (Argonne National Laboratory, Argonne, Illinois 60439 (USA)); Freedman, S.J.; Nelson, J.E.; Dewey, M.S.; Greene, G.L. *Physical Review Letters (USA)*, 63(25): 2721-2724 (18 Dec 1989). DOE Contract W-31-109-ENG-38.

We have measured the cross section for radiative capture of thermal neutrons on ^{3}He. The measured cross section of 54$\pm$6 μb is used to estimate the astrophysical *S* factor for the reaction ^{3}He($p,e^+\nu$)^{4}He which gives rise to high-energy neutrinos from the Sun.

6513 Nuclear Properties and Reactions, A = 6-19, Experimental

Refer also to citation(s) 25006

24996 (JINR-E–2-88-609) **Measurement of vector analyzing power of reactions d ↑ C - pX and d ↑ C-dX at 800 MeV/nucleon.** Beznogikh, G.G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy); Budilov, V.A.; Bogdanov, A.I. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1988. 4p. Order Number DE90620966. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

This paper reports on measurements of the vector analyzing power of the reactions d ↑ C - pX and d ↑ C -dX using 800 MeV/nucelon vector polarized deuterons. Emitted protons and deuterons of energies in the range 40-460 MeV have been detected at 75 deg and 102 deg (lab). The data are in a good agreement with the

experimental data for p ↑ C -pX reaction but disagree with nucleon knock-out model predictions. 4 refs.; 2 figs.

24997 (JINR-R–1-88-469) **Dependence of characteristics of $\pi^{\pm}$-mesons produced in π^{-}C-interactions at 40 GeV/c on total energy in the c.m.s. and QCD of semihard process.** Baatar, Ts. (Joint Inst. for Nuclear Research, Dubna (USSR)); Sehrdamba, L.; Tuvdendorzh, D.; Ivanovskaya, I.A.; Togoo, R. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 10p. (In Russian). Order Number DE90620967. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to Yad. Fiz.

The dependences on total energy in the c.m.s. of the average multiplicities and transverse momenta of $\pi^{\pm}$-mesons produced in π^{-}C-interactions at 40 GeV/c and of the transverse momentum squared distributions of $\pi^{\pm}$-mesons have been investigated. It is shown that the experimental characteristics can be described in the frame of the QCD of semihard processes. 8 refs.; 3 figs.; 3 tabs.

24998 (JINR-R–1-88-546) **Pion production multiplicity as a measure of excitation degree in nucleus-nucleus interactions at 3.66 A GeV.** Okonov, Eh.O. (Joint Inst. for Nuclear Research, Dubna (USSR)); Khusainov, E.K. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 8p. (In Russian). Order Number DE90620968. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The dependence of aveargе pion production multiplicity on the number of protons involved (Q) is considered for nucleus-nucleus interactions at 3.66 A GeV. It is shown that for collisions of nuclei of nearly equal mass ($A_P \approx A_T$) this dependence is linear as well as at lower energies. It makes possible an extrapoiation for the limiting case $Q_{max}=Z_P+Z_T$. Using the extrapolated value of pion yield the hadron matter temperature is estimated within the simplified thermodynamical approach which provides a fairly good description of the dependence of pion multiplicities on nuclear energy. An indication for linear increase in logarithmic scale of the temperature with energy is found for 0.1-3.7 A GeV energy region from the comparison of the value obtained (T_0=(120±2) MeV) for CC-interactions with Bevalac's data. 36 refs.; 6 figs.

24999 (JINR-R–1-88-645) **Summary characteristics of pions in nucleus-nucleus interactions at 4.2 GeV/c per nucleon.** Gulkanyan, G.R. (Erevanskij Fizicheskij Inst., Erevan (USSR)); Korchagin, S.A.; Ivanovskaya, I.A.; Kladnitskaya, E.N. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1988. 10p. (In Russian). Order Number DE90620969. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Data on the summery characteristics of pions (of all types) in multinucleon interactions of carbon nuclei with tantalum and carbon energy, on the average, expended on pion production is $\langle k \rangle$=0.23±0.02 of the summary kinetic energy of interacting nucleons of the projectile and weakly depends on the type of the target and on different samples of multinucleon interactions. The experimental results are compared with the statistical model. The moments of the distributions over total longitudinal momentum and over the sum of the transverse momentum modules for π^{-}, π^{+}-mesons and γ quanta in CTa interactions have been obtained. The experimental values of the moments are compared with the predictions based on the assumption of an independent character of projectile-nucleon interaction. 16 refs.; 6 tabs.

25000 (JINR-R–1-88-685) **Inclusive and multiple characteristics of cumulative protons in nucleus-nucleus interactions at 4.2 GeV/c per nucleon.** Gulkanyan, G.R. (Erevanskij Fizicheskij Inst., Erevan (USSR)); Ravinovich, I.M.; Cheplakov, A.P. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 11p. (In Russian). Order Number DE90620970. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

New experimental data on multiple and inclusive cumulative proton characteristics in the interactions of protons and d, He and C nuclei with carbon and tantalum at a primary momentum of 4.2 GeV/c per nucleon have been obtained. An approximate factorization of inclusive cross sections versus the atomic weight of the projectile and target is shown. An indication of some suppression of proton yields from the carbon target at large angles is obtained with increasing the atomic weight of the projectile. The experimental data are compared with the predictions of the multinucleon correlation model and a Dubna version of the cascade model (DCM). 17 refs.; 8 figs.; 9 tabs.

25001 (JINR-R–1-88-905) **Correlations of secondary particles in pC-,dC-, αC-, CC-interactions at 4.2 GeV/c per nucleon momentum.** Angelov, N. (and others); Grishin, V.G.; Didenko, L.A. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1988. 17p. (In Russian). Order Number DE90620971. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Processes of baryon clusters production and the correlation of secondary particles in pC-, dC-, αC-, CC- and π^{-}C-interactions within an interval of 4-40 GeV per nucleon are studied. It is shown that baryon clusters are characterized by universal properties on two relativistically invariant variables b_k and x_k at the considered energy. The azimuthal correlations between sngly charged stripping fragments of relativistic carbon nuclei have been found in carbon-carbon interactions. The peaks indicating the existence of narrow resonance states with masses (1903-1) MeV/c^2 and (1915-4) MeV/c^2 are observed in the effective mass spectra of two protons. 27 refs.; 10 figs; 2 tabs.

25002 (JINR-R–3-88-908) **Negative neutron p-resonance on ^{11}B nucleus.** Mitsyna, L.V.; Popov, A.B.; Samosvat, G.S. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics. 1988. 4p. (In Russian). Order Number DE90620972. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

For the first time in neutron spectroscopy an experimental estimate of the width of a negative p-wave resonance $G_n^1 \simeq 4500$ eV is obtained for the resonance - 709 keV, corresponding to the fourth excitated state of ^{12}B which has 2.72 MeV energy and spin 0^+. 12 refs.; 1 fig.

25003 Electroexcitation of rotational bands in ^{18}O. Manley, D.M. (Department of Physics and Center for Nuclear Research, Kent State University, Kent, Ohio 44242 (USA)); Millener, D.J.; Berman, B.L.; Bertozzi, W.; Buti, T.N.; Finn, J.M.; Hersman, F.W.; Hyde-Wright, C.E.; Hynes, M.V.; Kelly, J.J. *Physical Review, C (Nuclear Physics) (USA),* 41(2): 448-457 (Feb 1990). DOE Contract AC02-76ER03069.

The fourth 2^+ state in ^{18}O at an excitation energy of 8.21 MeV has been studied by high-resolution electron scattering. The Coulomb form factor for this state was measured in the momentum-transfer range $0.9 \leq q \leq 2.1$ fm^{-1} and the extracted $B(C2)\uparrow$ value was determined to be 7.3±4.2 e^2fm^4. The level at 8.21 MeV is identified as a four-particle, two-hole (4p2h) state of the type $p^{-2}(sd)^4$. Form-factor measurements in the range $1.0 \leq q \leq 1.9$ fm^{-1} are also presented for a strongly excited normal-parity state at 9.36 MeV. Preliminary measurements of the differential cross section for exciting this state by 135-MeV protons suggest a 2^+ assignment; the measured Coulomb form factor of this state allows it to be identified as the best experimental candidate for a predicted K=2 4p2h state with the four *sd*-shell nucleons coupled to T=0. The excitation of these states and other members of rotational bands in ^{18}O are discussed within the framework of structure models. Shell-model calculations for the $C4$ form factors of the first three 4^+ states in ^{18}O are compared to existing data.

25004 Valence capture mechanism in resonance neutron capture by ^{13}C. Raman, S. (Japan Atomic Energy Research Institute, Tokai-mura, Naka-gun, Ibaraki-ken, (Japan)); Igashira, M.; Dozono, Y.; Kitazawa, H.; Mizumoto, M.; Lynn, J.E. *Physical Review, C (Nuclear Physics) (USA),* 41(2): 458-471 (Feb 1990).

The partial radiation widths of three (two electric dipole and one electric quadrupole) primary γ transitions in ^{14}C, subsequent to neutron capture by the 153-keV, 2^+ resonance in ^{13}C, have been remeasured. Both electric dipole transitions, accounting for more than 80% of the total radiation width, can be explained as valence neutron transitions. The deduced total radiation width of $0.215_{-0.035}^{+0.084}$ eV for this resonance disagrees with the previous value of 2.4±0.9 eV and significantly affects the production of $A \geq 14$ nuclei in primordial nucleosynthesis.

25005 **$^{14}N(\gamma,\pi^+)^{14}C_{gs}$ at photon energies of 230, 260, and 320 MeV.** Ghedira, L. (Physics Department, Rensselaer Polytechnic Institute, Troy, New York, 12180 (USA)); Myers, D.; Cottman, B.H.; Sankhavaram, K.; Seneviratne, M.D.; Stoler, P.; Winhold, E.J.; Yamazaki, M.; Yergin, P.F.; Distelbrink, J.H.J. *Physical Review, C (Nuclear Physics) (USA),* 41(2): 653-658 (Feb 1990).

The pion angular distribution for $^{14}N(\gamma,\pi^+)^{14}C_{g.s.}$ has been measured at photon energies of 230 and 260 MeV. These data are consistent with the trend of our earlier data at 200 and 320 MeV. Additional forward angle data were obtained at 320 MeV. The results are compared to several calculations based on the distorted-wave impulse approximation and on the delta-hole model. The data are best fit by the calculations of Tiator *et al.* which use the delta-hole model in the resonance channel. These calculations fit the 230 MeV data well and underestimate the 260 and 320 MeV data by about 25%.

6514 Nuclear Properties and Reactions, A = 20-38, Experimental

Refer also to citation(s) 24998

25006 **Exotic light nuclei.** Detraz, C. (Grand Accelerateur National d'Ions Lourds, 14021 Caen Cedex, (France)); Vieira, D.J. *Annual Review of Nuclear and Particle Sciences (USA),* 39(1): 407-465 (1989).

The research on nuclei far from stability became possible because of significant developments in production and separation techniques. This research, combined with theoretical advances, sheds new light on the nuclear structure, binding, and decay characteristics of exotic nuclei.(AIP)

6516 Nuclear Properties and Reactions, A = 59-89, Experimental

25007 **Nuclear data sheets for A=69.** Bhat, M.R. (National Nuclear Data Center, Brookhaven National Laboratory, Upton, NY 11973 (US)). *Nuclear Data Sheets (USA),* 58(1): 1-91 (Sep 1989). DOE Contract AC02-76CH00016.

The 1982 evaluation of A=69 has been revised using experimental decay and reaction data received by January 18, 1989. Neutron reaction data: see the bibliography CINDA-A, CINDA-B, and supplements. © 1989 Academic Press, Inc.

25008 **Interacting boson fermion model description for the levels of $^{71}Ge_{39}$ populated in the beta decay of 65.30-h ^{71}As.** *Physical Review, C (Nuclear Physics) (USA),* 41(2): 686-696 (Feb 1990). DOE Contract W-7405-ENG-48.

We have studied the level properties of the N=39 nucleus ^{71}Ge by gamma-ray spectroscopy following the beta decay of ^{71}As, for which we measure a half-life of 65.30±0.07 h. When we calculated the level structure of ^{71}Ge within the framework of the interacting boson fermion model, we found good agreement with the experimentally determined level properties. Some evidence was found for the occurrence of levels built on the coexisting ^{70}Ge-core intruder state.

6517 Nuclear Properties and Reactions, A = 90-149, Experimental

25009 (JINR-E-1-88-639) **Retardation of hadrons in passing through intranuclear matter.** Strugalski, Z. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1988. 9p. Order Number DE90620979. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Hadrons are reduced in velocities by their passages through layers of intranuclear matter - due to strong interactions, similarly as electrified particles are reduced in velocities by their passages through layers of materials - due to electromagnetic interactions. The observed hadron energy loss in intranuclear matter can be treated as an analog of the well-known energy loss of electrified particles in materials. 24 refs.; 2 figs.; 1 tab.

25010 (JINR-E-15-88-864) **In-beam study of low-lying levels in the ^{149}Sm nucleus.** Simecek, P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems); Julin, R.; Juutinen, S. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems; Jyvaeskylae Univ. (Finland). Dept. of Physics. 1988. 19p. Order Number DE90620980. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

^{149}Sm low-lying states are excited in ^{146}Nd (a,nγ) reaction. Individual spectra of γ-radiation and internal conversion electrons, $\gamma\gamma$ coincidences, γ-radiation angular distributions and excitation functions are measured. The work has resulted in a more precise ^{149}Sm level scheme and new data on γ-radiation multipole composition. The experimental information obtained is compared with the results within the framework of the rotation model. 20 refs.; 5 figs.; 4 tabs.

25011 (JINR-R-3-88-806) **Study on the $^{91}Zr(n,a)^{88}Sr$ reaction at neutron resonance energies.** Gledenov, Yu.M.; Mitrikov, M.P.; Chadraabal, I. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics. 1988. 8p. (In Russian). Order Number DE90620981. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The (n,a) reaction on the ^{91}Zr isotope was investigated in the neutron energy range up to 5 keV. The measured cross section has shown three neutron resonances at E_0=2.474; 1.531 and 0.449, which a-widths were determined to be 165±46, 12±7, and 31±10 μ eV respectively. These results were compared with those calculated in terms of the cluster and statistical models. 21 refs.; 3 figs.; 3 tabs.

25012 (JINR-R-6-88-755) **Gamma-rays in the $^{146}Eu \rightarrow ^{146}Sm$ decay.** Adam, I. (Ceskoslovenska Akademie Ved, Rez (Czechoslovakia). Ustav Jaderne Fyziky); Kracik, B.; Tlusty, P.; Batsev, S.K.; Zhelev, Zh.T.; Yushkevich, Yu.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 17p. (In Russian). Order Number DE90620982. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Gamma-rays of $^{146}Eu \rightarrow ^{146}Sm$ decay were measured on the anti Compton spectrometer. 293 γ-transitions were attributed to ^{146}Eu decay, 134 of them having been observed for the first time. For other transitions the accuracy of determination of I_γ, E_γ was improved several fold. Conversion electron spectra were measured with Si(Li) detector. ^{I}K were determined for 105 transitions, for four of them - for the first time. Relative intensities of differential-integral coincidences were measured for 130 transitions. 20 refs.; 2 tabs.

6518 Nuclear Properties and Reactions, A = 150-189, Experimental

Refer also to citation(s) 25000

25013 (JINR-R-1-88-858) **Correlations over multiplicity between negative pions and protons-participants in CTa interactions at 4.2 GeV/c per nucleon momentum.** Batskovich, S. (Institutul de Fizica si Inginerie Nucleara, Bucharest (Romania)); Boldea, V.; Grishin, V.G. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1988. 14p. (In Russian). Order Number DE90620987. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The dependence of the average multiplicity of π^--me-sons n_{π^-} on the number of proton participants (N_p) for CTa interactions at a momentum of 4.2 GeV/c per nucleon has been studied. The linear growth of n_π with N_p increasing shown before in colliding of equal mass nuclei is observed only for noncentral CTa interactions. An important role of nucleon-participants from the projectile as compared with the target ones is shown in this dependence. The data obtained are well described in the model frame of independent interactions of projectile nucleons with target-nucleus. 20 refs.; 7 figs.; 3 tabs.

25014 (JINR-R-3-88-824) **Detection and study on the $^{187}Os(n,\alpha)^{184}W$ reaction on the resonance neutrons.** Andrzejewski, J.; Gledenov, Yu.M.; Popov, Yu.P.; Sedyshev, P.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics. 1988. 6p. (In Russian). Order Number DE90620988. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The paper reports on the results of the study on the α decay of highly-excited states of ^{188}Os. The experiment was performed by the time-of-flight method and neutron beam from the IBR-30 booster. For the first time one has succeeded in measuring with using of a two-section ionization chamber with a grid α-widths of $(6.8\pm1.0)\times10^{-9}$ eV and $(2.0\pm0.3)\times10^{-9}$ eV for two resonances at E_0=9.47eV and E_0=12.7 eV, respectively. Average α-widths were found to be $(17\pm10)\times10^{-9}$ eV and $(6.3\pm4.7)\times10^{-9}$eV over two neutron energy intervals from 38 to 53 eV and from 53 to 150 eV, respectively. Experimental α-particle strength functions are compared to those calculated within the black nucleus model. 15 refs.; 3 figs.; 2 tabs.

25015 **Nuclear data sheets for A=152.** Peker, L.K. (National Nuclear Data Center, Brookhaven National Laboratory, Upton, New York 11973 (US)). *Nuclear Data Sheets (USA),* 58(1): 93-241 (Sep 1989). DOE Contract AC02-76CH00016.

The experimental nuclear structure data available through November 1987 have been reviewed. A summary of information obtained in various reaction and decay experiments is presented, together with adopted level schemes. © 1989 Academic Press, Inc.

25016 **Nuclear data sheets for A=184.** Firestone, R.B. (Lawrence Berkeley Laboratory, Berkeley, California 94720 (US)). *Nuclear Data Sheets (USA),* 58(1): 243-349 (Sep 1989). DOE Contract AC03-76SF00098.

Spectroscopic data for all nuclei with mass number A=184 have been evaluated, and the corresponding level schemes from radioactive decay and reaction studies are presented. © 1989 Academic Press, Inc.

25017 **Nuclar data sheets for A=185.** Browne, E. (Nuclear Science Division, Lawrence Berkeley Laboratory, 1 Cyclotron Raod, Berkeley, California 94720 (US)). *Nuclear Data Sheets (USA),* 58(2): 441-554 (Oct 1989). DOE Contract AC03-76SF00098.

Evaluated spectroscopic data for all nuclei with mass number A=185, and corresponding level schemes from radioactive decay and reaction studies, are presented. New experimental evidence indicates a possible coexistence of prolate and oblate nuclear shapes in the Au and Hg isotopes. This evaluation for A=185 supersedes the earlier one by Y. A. Ellis-Akovali (81El11). © 1989 Academic Press, Inc.

6519 Nuclear Properties and Reactions, A = 190-219, Experimental

25018 (GANIL-P–89-08) **Hot nuclei studies with a 4 π-Neutron detector.** Galin, J.; Crema, E.; Doubre, H.; Guerreau, D.; Jiang, D.X.; Morjean, M.; Piasecki, E.; Pouthas, J.; Saint-Laurent, F.; Sokolov, A. Grand Accelerateur National d'Ions Lourds (GANIL), 14 - Caen (France). 1989. 18p. (CONF-8904153–: Symposium on nuclear dynamics and nuclear disassembly, Dallas, TX (USA), 9-14 Apr 1989). Order Number DE90762028. Available from NTIS (US Sales Only), PC A03/MF A01.

When studying the behavior of hot nuclei, the challenge is twofold: how are they formed in nucleus-nucleus collisions and how do they decay Systematic studies have been undertaken at GANIL by bombarding heavy targets (Au, Th) with intermediate energy projectiles (27, 35, 44 and 77 MeV/u Ar and 32 MeV/u Kr). For such neutron rich systems the thermalized energy can be roughly evaluated simply by measuring the multiplicity of evaporated neutrons using a 4 π Gd loaded, liquid scintillator detector. The influence of the bombarding energy and projectile mass on the energy dissipation has been investigated for different exit channels and special emphasis has been put in the study of the most dissipative collisions. The thermal energy, derived by summing the energy removed by both evaporated neutrons and light charged particles is shown to saturate at $E^* \simeq 650$ MeV in the Ar induced reactions between 27 and 77 MeV/u, in good consistency with the predictions of semi-classical Landau-Vlasov calculations.

25019 (JINR-R–1-88-312) **Application of robust fitting to determination of isobaric cross sections of residual nuclei in relativistic interactions.** Damdinsurehn, Ts.; Kozma, P.; Zlokazov, V.B. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 9p. (In Russian). Order Number DE90620990. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

It is shown that using of robust fitting in relativistic interactions could determine isobaric cross sections of radionuclides for further theoretical analysis with rather good accuracy. Using this method charge dispersions and mass distributions of residual nuclei were determined in ^{197}Au(P,X) and ^{197}Au(^{12}C,X) interactions at 3.65 GeV/nucleon energy. 6 refs.; 3 figs.; 3 tabs.

25020 (JINR-R–7-88-830) **Measurement of cross sections of light particle evaporation reactions in total fusion channel on Au and Pb irradiation by Ne ions.** Andreev, A.N. (and others); Bogdanov, D.D.; Eremin, A.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions. 1988. 12p. (In Russian). Order Number DE90620991. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The experiments were carried out with the use of Vassilissa kinematic separator. The data on characteristics of radioactive decay of two isotopes were obtained: ^{225}U E_α=7.87±0.01 MeV $T_{1/2}=30^{+20}_{-10}$ms, ^{226}U E_α=7.57±0.01 MeV $T_{1,2}=0.25^{+0.15}_{-0.1}$s. Decay properties of ^{214}Ac, ^{223}Th, ^{219,220}Ra were measured more accurately. The data obtained provided evidence that there is an additional factor increasing the relative yield of (α,xn) reactions. It is possible to use the data on cross sections (α,xn) reactions for investigations of dependence of fission barrier on excitation energy of a nucleus. 14 refs.; 6 figs.; 3 tabs.

6520 Nuclear Properties and Reactions, A = 220 and Above, Experimental

Refer also to citation(s) 25018

25021 (GANIL-P–89-11) **Hot Nuclei: binary fission and intermediate mass fragments production.** Harar, S. (Grand Accelerateur National d'Ions Lourds (GANIL), 14 - Caen (FR)). Grand Accelerateur National d'Ions Lourds (GANIL), 14 - Caen (France). 1989. 14p. (CONF-8904153–: Symposium on nuclear dynamics and nuclear disassembly, Dallas, TX (USA), 9-14 Apr 1989). Order Number DE90762029. Available from NTIS (US Sales Only), PC A03/MF A01.

Three main topics concerning different experiments achieved to form hot nuclei and to investigate their decay properties via intermediate mass fragments (IMF) are discussed. (i) Linear momentum transfer (LMT) have been measured for the Kr + Th system at 25, 35 and 45 MeV/u. The scaling of LMT with the projectile mass is observed for Krypton ions. Energy deposited in the composite system is evaluated via massive transfer and exciton model calculations. (ii) LMT gated by IMF emitted in the backward hemisphere for the Ar + Th system at 31 and 44 MeV/u show a strong selectivity to the most violent collisions leading to fusion-fission process. IMF multiplicities don't indicate onset of multifragmentation mechanism. (iii) Transition from sequential fission to multifragmentation has been investigated by α projectiles at 70, 250 and 800 MeV/u. Mass and velocity distributions of the coincident fragments as well as their angular correlations allow to identify different reactions mechanisms. IMF properties are consistent with a simultaneous break-up of the nucleus.

25022 (JINR-E–7-88-803) **Observation of nucleon clusters in the spontaneous decay of ^{234}U.** Tret'yakova, S.P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions); Zamyatnin, Yu.S.; Korotkin, Yu.S.; Mikheev, V.L.; Kovantsev, V.N.; Timofeev, G.A. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions. 1988. 12p. Order Number DE90620992. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The emission of Ne and Mg nuclei was detected in the spontaneous decay of ^{234}U with probabilities of, respectively, $(3.9\pm1.0)\times10^{-13}$ and $(2.3\pm0.7)\times10^{-13}$ relative to α-decay. The upper limits of this kind of decay for ^{235}U and ^{236}U have been established. Systematics of half-lives for cluster emission have been obtained to be similar to the Geiger-Nuttall dependence for α-decay. Some evidence for the presence of hidrance to cluster emission from the odd-mass nuclei ^{233}U and ^{235}U is obtained. 15 refs.; 4 figs.; 2 tabs.

25023 **Nuclear structure of ^{238}Np from neutron-capture and α-decay measurements.** Hoff, R.W. (Lawrence Livermore National Laboratory, Livermore, California 94550 (US)); Kern, J.; Strassmann, W.; Schreckenbach, K.; Barreau, G.; Mann, L.G.; White, D.H.; Landrum, J.H.; Dupzyk, R.J.; Kane, W.R. *Physical Review, C (Nuclear Physics) (USA),* 41(2): 484-512 (Feb 1990).

The experimental measurements made in this investigation include secondary γ rays and conversion electrons from thermal neutron capture in ^{237}Np, primary γ rays from average resonance capture with a 2-keV neutron beam and from resonance capture with thermal neutrons, and α particles and γ rays, singles and coincidences, from ^{242}Am^{m} α decay. From these data and those of previous investigations, 69 excited levels in ^{238}Np with energies <700 keV were identified and, of these, 46 were placed in 13 rotational bands with assigned Nilsson configurations. The results are found to be in good agreement with a semiempirical model calculation. A special feature is the observation of four different K=0 rotational bands in the low-energy structure of ^{238}Np. Experimentally determined Gallagher-Moszkowski and Newby matrix elements show reasonable agreement with calculated values.

25024 **Nuclear data sheets for A=229.** Akovali, Y.A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6371, USA (US)). *Nuclear Data Sheets (USA),* 58(2): 555-588 (Oct 1989). DOE Contract AC05-84OR21400.

The available nuclear structure information for all nuclei with mass number A=229 is evaluated. The results from various decay experiments and reaction studies are compared. Adopted data, levels, and spin and parity assignments are given. © 1989 Academic Press, Inc.

25025 **Nuclear Data Sheets for A=246–266(even).** Schmorak, M.R. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6371 (US)). *Nuclear Data Sheets (USA),* 57(4): 515-629 (Aug 1989). DOE Contract AC05-84OR21400.

Experimental data pertaining to the nuclear structure of nuclei with even mass numbers A=246 through A=266 have been compiled and evaluated (the odd–A mass chains, A=245 through A=263, are current being revised for publication). In many cases where data are lacking, systematics developed by 72E121 and 81Sc06 was used to obtain the needed values. Particularly useful are the systematic trends of $T_{1/2}(\alpha)$ versus $E(\alpha)$, $Q(\alpha)$ versus neutron number and the α's HF's for favored bands. The systematics of low-lying Nilsson levels were used in numerous $J\pi$ assignments. $J\pi$ are from "adopted levels" unless stated otherwose. $J\pi$ for g.s. bands in even-even nuclei are assigned on the basis of the level energies. © 1989 Academic Press, Inc.

25026 **Spontaneous fission properties of 2.9-s ^{256}No.** Hoffman, D.C.; Lee, D.M.; Gregorich, K.E.; Nurmia, M.J.; Chadwick, R.B.; Chen, K.B.; Czerwinski, K.R.; Gannett, C.M.; Hall, H.L.; Henderson, R.A. *Physical Review, C (Nuclear Physics) (USA),* 41(2): 631-639 (Feb 1990). DOE Contract AC03-76SF00098.

We have measured the mass and kinetic-energy distributions of fragments from the spontaneous fission of ^{256}No produced via the ^{248}Cm(^{12}C,4n) reaction. The production cross section using 71-MeV ^{12}C projectiles was found to be 250 nb. The total kinetic energy for spontaneous fission of ^{256}No is 196±3 MeV. The mass distribution is very broad (full width at half maximum of ~50 mass units) with no appreciable decrease in yield for symmetric mass division. ^{256}No seems to be the transition nucleus between the asymmetric mass division observed for spontaneous fission of the lighter No isotopes and the symmetric mass division observed for the heavier No isotopes. Its properties are similar to those of ^{257}Fm, the isotope at which this transition occurs in the Fm isotopes, but the ^{256}No mass distribution is broader than that for ^{257}Fm, and its average total kinetic energy for symmetric mass division is about 15 MeV lower. We determined the half-life of ^{256}No to be 2.91±0.05 s by measuring its α decay. We measured a spontaneous fission to α ratio of $0.0053_{-0.0003}^{+0.0006}$, which gives a partial half-life for spontaneous fission of 550_{-70}^{+40} s. An energy of 8.448±0.006 MeV was measured for the α-particle decay to the ground state of ^{252}Fm, allowing us to calculate the mass excess for ^{256}No as 87820±8 keV. The energy of the 2^{+} rotational level in the ^{252}Fm daughter is 47±5 keV, and the intensity of the 8.402-MeV α group populating this level is (13±2)%.

25027 **Electron-capture-delayed fission properties of ^{234}Am.** Hall, H.L.; Gregorich, K.E.; Henderson, R.A.; Gannett, C.M.; Chadwick, R.B.; Leyba, J.D.; Czerwinski, K.R.; Kadkhodayan, B.; Kreek, S.A.; Lee, D.M. *Physical Review, C (Nuclear Physics) (USA),* 41(2): 618-630 (Feb 1990). DOE Contract AC03-76SF00098.

Delayed fission following the electron-capture decay of ^{234}Am was studied. The ^{237}Np(α,7n)^{234}Am reaction with multiple ^{237}Np targets was used to produce ^{234}Am. The fission properties and half-life of ^{234}Am were measured using a rotating-wheel system. The half-life of ^{234}Am was determined to be 2.32±0.08 min from measurements of the fission activity. A highly asymmetric mass-yield distribution was observed for the fission activity, and the average total kinetic energy of the fission fragments was found to be 173±5 MeV. Radiochemical separations confirmed the elemental assignment of the fissioning species to americium or fission from short-lived excited states in its EC daughter, plutonium. The cross section for ^{234}Am produced by this reaction and decaying by electron capture was determined to be 5.4±1.3 μb by measuring the intensities of the daughter plutonium K x rays in radiochemically separated americium samples. The branching ratio of the 6.46-MeV α peak of ^{234}Am was found to be $(3.9\pm1.2)\times10^{-4}$ in on-line measurements. The delayed-fission probability was determined to be $(6.6\pm1.8)\times10^{-5}$ from the measured ratio of fissions to plutonium K x rays. The observed fissions were unambiguously assigned to an EC-delayed fission process by measuring fissions coincident with the K-capture x rays.

25028 **Prompt neutron emission from the spontaneous fission of ^{260}Md.** Wild, J.F.; van Aarle, J.; Westmeier, W.; Lougheed, R.W.; Hulet, E.K.; Moody, K.J.; Dougan, R.J.; Koop, E.; Glaser, R.E.; Brandt, R. *Physical Review, C (Nuclear Physics) (USA),* 41(2): 640-646 (Feb 1990). DOE Contract W-7405-ENG-48.

We have made the first measurement of the number of neutrons emitted from the spontaneous fission of a nuclide in which very high fragment energies dominate the fission process. In bombardments of ^{254}Es, we produced a large sample of 28-d ^{260}Md, which was neutron counted in a 1-m-diameter spherical tank containing a Gd-doped scintillator solution. The average number of neutrons emitted per fission is only 2.58±0.11, substantially less than for other actinides. A linear dependence of neutron multiplicity on fragment-excitation energy is observed to the highest values of total kinetic energy.

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Refer also to citation(s) 24829, 24991, 25010

25029 (CEA-CONF–9906) **Cold fragmentation properties: a crucial test of the dynamics of fission.** Simon, G.; Trochon, J.; Signarbieux, C. CEA Centre d'Etudes de Bruyeres-le-Chatel, 91 (France). 1989. 3p. (CONF-890406–: Fifty years with nuclear fission conference, Gaithersburg, MD (USA), 25-28 Apr 1989). Order Number DE90762039. Available from NTIS (US Sales Only), PC A02/MF A01.

Very often in the literature, the descent from saddle to scission in the low energy fission of even-even actinides is cited as an example of a process in which a large scale collective rearrangement of nuclear matter is realized without (or with a very low) dissipation of the collective kinetic energy into quasi-particle excitation. As a matter of fact, a systematic and strong even-odd effect in fragment charge distributions as well as a fine structure in mass distributions have been interpreted as an indication that the superfluidity of these fissioning systems (known to be completely paired at the saddle point) should be, to a large extent, preserved up to scission. We present here a set of experimental results concerning the thermal neutron induced fission of ^{233}U, ^{235}U, ^{239}Pu and the spontaneous fission of ^{252}Cf, which are in contradiction with such an interpretation.

25030 (CEAC-R–5-89) **Measurement of the fission cross-section ratio for ^{237}Np/^{235}U around 14 MeV neutron energies.** Desdin, L. (Instituto Superior de Ciencia y Tecnologia Nuclear, La Habana (Cuba)); Szegedy, S.; Csikai, J. Comision de Energia

Atomica, La Habana (Cuba). 1989. 12p. Order Number DE90620952. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Fission cross-section ratio was determined for $^{237}Np/^{235}U$ around 14 MeV neutron energies with a back-to-back ionization chamber. Neutrons were produced by a 180 KV accelerator using $T(d,n)^4He$ reaction. No significant energy dependence was found in the cross section ratio.

25031 (JINR-E-1-88-754) **Space-time characteristics of secondary proton sources in relativistic nuclear collisions from two-particle correlations.** Pluta, J. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1988. 8p. Order Number DE90620927. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Recent experimental results on two-proton correlations at small relative momenta are discussed. Dependence of the size of the proton emission volume on the momenta of emitted protons has been analyzed to find a plausible description of the observed effects. Two factors were tested: large emission time intervals and small perpendicular source sizes. Each of these factors is supposed to dominate in different proton momentum intervals. Analysis of the experimental data shows that there are several interrelated contributions to the observed effects. 30 refs.; 5 figs.

25032 (JINR-E-2-88-498) **Nuclear structure functions and J/Φ meson yield suppression in nuclear collisions.** Efremov, A.V.; Kim, V.T.; Shmakov, S.Yu.; Izhinskij, V.V. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 6p. Order Number DE90620928. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

It is shown that a part of J/Φ meson yield suppression (about 1/5), observed by the NA-38 group in central collisions of nuclei ^{16}O and ^{238}U and considered as a signal of the quark-gluon plasma, can be explained by the difference between the qurk-gluon structure of the nucleus and that of a free nucleon (like the EMC-effect). 13 refs.

25033 (JINR-E-2-88-588) **Extended thermodynamics of interpenetrating nuclear matter.** Kaempfer, B. (Joint Inst. for Nuclear Research, Dubna (USSR)); Lucacs, B.; Wolf, Gy.; Barz, H.W. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 16p. Order Number DE90620925. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Yad. Fiz.

A relativistic phenomenologically extended thermodynamical model is presented which allows for the mutual inperpenetration of nuclei, thus taking into account the finiteness of the nucleon mean free path. The stopping of nuclei during their high-energy collision process appears as gradual process. Fluid elements with two interpretating subsystems are treated as unique matter with an additional internal degree of freedom, being the representative of the relative velocity of the subsystems or the anisotropy of the distribution function. The dynamics of this additional degree of freedom is properly included. 11 refs.; 5 figs.

25034 (JINR-E-2-88-732) **DIAGEN-generator of inelastic nucleus-nucleus interaction diagrams.** Shmakov, S.Yu.; Uzhinskij, V.V.; Zadorozhnyj, A.M. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation. 1988. 16p. Order Number DE90622147. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Description of the program code generating inelastic nucleus-nucleus interaction diagrams is given. Probabilities of various diagram appearance are determined within the framework of Glauber approximation. The code allows one to determine cross sections of any processes and the number of spectator nucleons. 12 refs.; 2 figs.

25035 (JINR-E-4-88-673) **Unified semimicroscopic approach scattering of low energy protons and alpha-particles by nuclei.** Dao Tien Khoa (Joint Inst. for Nuclear Research, Dubna (USSR)); Kukhtina, I.N.; Knyaz'kov, O.M.; Feofilov, G.A. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 20p. Order Number DE90620929. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The unified approach has been developed to the description of the interaction of low energy nucleons and α-particles with nuclei. The analysis of elastic and inelastic scattering of 25.05 MeV protons and 104 MeV α-particles from ^{90}Zr is made. The differences in deformations of neutron and proton density distributions for ^{90}Zr nucleus are extracted. The energy dependence of the obtained α-particle - nucleus semimicroscopic potential is investigated, including the energy dependence for the geometry of the potential. The feaures of angular distributions of elastic α-particle scattering and the role of nucleon-nucleon correlations are analysed as a function of α-particle energy.

25036 (JINR-E-4-88-737) **Quasiparticle-phonon nuclear model equations with effective separable interactions of a finite rank.** Solov'ev, V.G. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 18p. Order Number DE90620906. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The quasiparticle-phonon nuclear model equations are obtained for the finite rank separable isoscalar and isovector multipole and spin-multipole and isovector tensor particle-hole and particle-particle interactions between quasiparticles. For doubly even spherical nuclei allowance for separable interactions of the rank n_{max} leads to a considerable complication of equations in the random phase approximation. Separable interactions with $n_{max}>1$ do not cause any significant complication in calculating the fragmentation of quasiparticle and collective states. It is asserted that the model can serve as a basis for calculating many characteristics of complex nuclei. 24 refs.

25037 (JINR-E-4-88-780) **Theoretical investigation of neutron emission in the interaction of ^{12}C(105 MeV) and ^{20}Ne(180 MeV) ions with nuclei.** Ivanova, S.P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics); Tomas, J. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 12p. Order Number DE90620930. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The description of the high-energy particle emission is calculated in the framework of the early suggested model for the reactions of ^{12}C (105 MeV), ^{20}Ne(180 MeV) ions with nuclei. The low-energy neutron yield is calculated by cascade-evaporative model. 14 refs.; 6 figs.

25038 (JINR-E-4-88-800) **Relaxation times of collective modes in the fission of excited nuclei.** Adeev, G.D. (Omskij Gosudarstvennyj Univ., Omsk (USSR)); Gonchar, I.I.; Serdyuk, O.I.; Pashkevich, V.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 15p. Order Number DE90620953. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Relaxation times for the mass-asymmetric, charge and neck modes in the fission of excited compound nuclei have been calculated. The modes are harmonical in good approximation during the descent of the fissioning nucleus from the saddle point to scission. The oscillators of all modes exhibit a similar behaviour: during the first stage of the descent all of them are underdamped and become overdamped nearer to scission due to a sharp increase in inertia and friction parameters. The results are compared with available experimental data on characteristic times in the fission of excited nuclei, as well as with the relaxation times observed in dissipative heavy-ion collisions and quasifission reactions. 34 refs.; 6 figs.

25039 (JINR-E-4-88-808) **Pontecorvo reactions of two-body antiproton annihilation in deuterium.** Kondratyuk, L.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki); Sapozhnikov, M.G. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 10p. Order Number DE90620931. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Rare annihilation reactions for stopped antiprotons in deuterium, p-bard$\rightarrow\pi^-p$; $K^+\Sigma^-$; $K^0\Lambda$, are considered using the two-step model described by the triangle diagram. It was found that the probabilities, W, of these processes are very sensitive to the behaviour of the deuteron wave function at small distances as well as to the meson form factors. It appears that the ratios $R(KX)=W(KX)/W(\pi^-p)$ are much less model-dependent and are about 10^{-2} for $R(K^0\lambda)$ and 10^{-4} for $R(K^+\Sigma^-)$. 17 refs.; 1 fig.; 3 tabs.

25040 (JINR-E-4-88-886) **Collective 0^+, 1^+ and 2^+ excitations in rotating nuclei.** Balbutsev, E.B.; Piperova, J. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 27p. Order Number DE90620907. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The energies and $B(E\gamma)$ factors of the isoscalar and isovector 0^+ and 2^+ resonances are calculated with Skyrme interaction. A satisfactory agreement with experimental data is obtained. It is shown that in rotating nuclei the 2^+ excitations split into five branches and also 5 low-lying excitations appear. Two of these low-lying modes are angular resonances and the theory reproduces their energies and B(M1) factors. The experimentally observed splitting of giant monopole resonance in deformed nuclei is confirmed. 34 refs.; 10 figs.; 1 tab.

25041 (JINR-E-4-89-94) **On the role of the second well of the deformation potential energy in nuclear fission in the lead region.** Rastopchin, E.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk (USSR). Fiziko-Ehnergeticheskij Inst.); Smirenkin, G.N.; Pashkevich, V.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 10p. Order Number DE90620954. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The influence of the deformation-dependent attenuation of the rotational enhancement of the level density on the fission probability is discussed. It is shown that the difference in fissility between spherical and deformed nuclei can be explained by taking into account neutron emission by the nucleus in the second well of the deformation potential energy. 13 refs.; 1 fig.

25042 (JINR-R-1-88-760) **Analysis of transverse energy spectra in collisions of light relativistic nuclei.** Mekhtiev, R.R. (AN Azerbajdzhanskoj SSR, Baku (USSR). Inst. Fiziki); Cheplakov, A.P. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1988. 6p. (In Russian). Order Number DE90620932. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Transverse energy spectra E_T^{TOT} of charged secondary particles are investigated in collisions of proton, deuterium, helium and carbon nuclei with carbon target and in CTa interactions at 4.2 GeV/c per nucleon. Spectra can be well reproduced basing on the superposition of independent interactions of nucleons. It is shown that a more pronounced contribution to higher values of E_T^{TOT} give single secondaries with high transverse momenta. 9 refs.; 4 figs.; 1 tab.

25043 (JINR-R-2-88-898) **About applicability of wounded nucleon model at intermediate energies.** Pak, A.S. (AN Kazakhskoj SSR, Alma-Ata (USSR). Inst. Fiziki Vysokikh Ehnergij); Uzhinskij, V.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation; AN Kazakhskoj SSR, Alma-Ata (USSR). Inst. Fiziki Vysokikh Ehnergij. 1988. 6p. (In Russian). Order Number DE90620933. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

In the framework of the wounded nucleon model with using the Glauber nucleus-nuclear interaction cross section calculating technique a successful description of the multiplicity distributions of produced particles in nucleus-nuclear collisions at 4.5 AxGeV/c is achieved. 17 refs.; 5 figs.

25044 (JINR-R-4-88-528) **Angular distribution and polarization of gamma-rays in resonance reactions with polarized particles. General expression.** Efimov, V.N. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 10p. (In Russian). Order Number DE90620934. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The general expressions for the angular distribution and the linear and circular polarizations of gamma-rays are obtained in the frame of R-matrix theory. These expressions are obtained in the case of arbitrary polarization of the particle in the initial channel. The expression is used for the amplitude in accordance with R-matrix theory taking into account the requirements of the time-reversal invariance. 13 refs.

25045 (JINR-R-4-88-642) **Investigation of statistical γ-rays in heavy ion induced reactions.** Ershov, S.N.; Ivanova, S.P. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 11p. (In Russian). Order Number DE90620935. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Yad. Fiz.

Statistical γ-rays in heavy-ion induced reactions with an energy <or approx. 10 MeV/nucl. are studied. It is shown that total γ-spectra do not permit us to get correct information about the form and position of giant dipole resonances. 15 refs.; 5 figs.; 2 tabs.

25046 (JINR-R-4-88-660) **Fluctuations in the superfluid model for heated spherical nuclei at finite temperature.** Nguen Dinh Dang (Moskovskij Gosudarstvennyj Univ., Moscow (USSR)); Nguen Zuy Thang. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 16p. (In Russian). Order Number DE90620908. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Z. Phys., A.

The effect of the nonvanishing thermal pairing gap due to statistical fluctuations is investigated by calculating fluctuations of selected observables such as the energy and particle number fluctuations, the nuclear level density, the level density parameter and the specific heat within the framework of the thermal nuclear superfluid model. In numerical calculations for heated spherical nuclei ^{58}Ni, ^{142}Sm and ^{208}Pb the realistic single-particle energy spectra defined in the Woods-Saxon potential are used. It is found that the results obtained with the nonvanishing thermal average pairing gap can yield an adequate estimate of the true fluctuations in the finite heating nonrotating nuclear systems. 25 refs.; 6 figs.

25047 (JINR-R-4-88-718) **The influence of nuclear surface diffuseness on the negative parity collective states.** Bal'butsev, E.B. (Joint Inst. for Nuclear Research, Dubna (USSR)); Mikhajlov, I.N.; Stoitsov, M.V. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 7p. (In Russian). Order Number DE90620909. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The centroids and the excitation reduced probabilities of the collective 2^- and 3^- states are calculated. It is shown that the results are sensitive to density distribution on the nuclear edge and that it is necessary to take this distribution into account to describe experimental data. 7 refs.; 3 figs.

25048 (JINR-R-4-88-735) **Influence of the shell effects on the production of the light nuclei in heavy-ion collisions.** Antonenko, N.V. (Tomskij Politekhnicheskij Inst., Tomsk (USSR)); Dzholos, R.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 14p. (In Russian). Order Number DE90620910. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Various approaches to calculate the coefficients of the transport equation describing the process of the multinucleon transfer have been analyzed. It is shown that the expressions for the transition probabilities containing the effects of the nuclear shell structure can be obtained if it is not use averaging of the matrix elements over many shell configurations. On this basis in the framework of the model with the degenerated shells the production of the light nuclei in the heavy-ion reactions is investigated. The calculations performed under the assumption that the wave functions of the high-lying single-particle states of the system do not concentrated in one nucleus but distributed among both nuclei proportionally to their volumes gives much higher production probabilities for light nuclei than the results obtained under the assumption that the single-particle states belong only to one of the interacting fragments. 10 refs.; 6 figs.

25049 (JINR-R-4-88-763) **Damping of the isovector giant dipole resonances in heated even-even spherical nuclei.** Dang, N.D. (Moskovskij Gosudarstvennyj Univ., Moscow (USSR)). Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 22p. (In Russian). Order Number DE90620911. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

An approach based on the finite remperature quasiparticle phonon-nuclear model with account of interaction (2p-2h) at finite temperature taken into account is suggested for calculations of the damping of giant multipole resonances in heated even-even spherical nuclei. The strength functions for the isovector giant dipole resonances (IV-GDR) are calculated in ^{58}Ni and ^{90}Zr for temperatures from 0 to 3 MeV. The results show that the contribution of

the interactions with (2p-2h) configurations to the IV-GDR spreading width changes weakly with growth temperature. The IV-GDR centroid energy decreases slightly with increasing temperature. The nonvanishing superconducted pairing gap due to thermodynamical fluctuations at finite temperatures is included. 61 refs.; 7 figs.; 1 tab.

25050 (JINR-R–4-88-799) **Selfconsistent calculation of the potentials of nucleons and deuterons interaction with ^{6}Li nucleus.** Kamal, M. (Cairo Univ. (Egypt)); Voronchev, V.T.; Kukulin, V.I. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 20p. (In Russian). Order Number DE90620912. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Interactions for the N+^{6}Li and d+^{6}Li systems are calculated, by using the multicluster dynamical model of ^{6}Li and the folding model for N-N and N-a potentials of the interacted particles. In this case we use the same N-N and N-a interactions as the ones used for the calculation of the dynamical model of the target ^{6}Li i.e. the calculations of the real part of the potentials are compatible and do not contain free parameters. The predicted theoretical calculations are in good agreement with the corresponding experimental data on the differential cross-section of elastic scattering of the nucleons and deuterons on ^{6}Li. The interaction potentials found are approximated in the standard Woods-Saxon form. 27 refs.; 11 figs.

25051 (JINR-R–4-88-845) **Equations for O^+ states in deformed nuclei.** Solov'ev, V.G. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 12p. (In Russian). Order Number DE90620913. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The quasiparticle-phonon nuclear model (QPRM) equations are derived for describing the $K^\pi=O^+$ states in even-even deformed nuclei taking account of particle-hole and particle-particle interactions between quasi particles. Inclusion of particle-particle interactions complicates the random phase approximation (RPA) equations. Equations for the functions of monopole and quadrupole pairing are derived from the condition of eliminating spurious RPA solutions. In the QPNM, inclusion of a particle-particle interaction does not lead to very complicated calculations. The obtained equations can serve as a basis for calculating characteristics of the $K^\pi O^+$ states of even-even deformed nuclei. 18 refs.

25052 (JINR-R–4-88-848) **Angular distribution and polarization of γ-quanta in resonant reactions with polarized particles. Two-level interference.** Efimov, V.N. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics. 1988. 9p. (In Russian). Order Number DE90620936. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The resonant (n,γ) reactions with polarized neutrons are considered in the framework of the standard R-matrix theory. Two resonances with the same spins but with different parity (s-levels and p-levels) are taken into account. The angular and neutron energy dependence of linear and circular polarizations of gamma-rays is obtained. As a concrete example the ^{117}Sn(n,γ) reaction is considered for which the results of measuring th P-even angular correlations of γ-quanta are known. 4 refs.; 1 tab.

25053 (JINR-R–4-88-933) **Systematic and analysis of nucleus properties of ytterbium odd isotopes with A=163-173: Nonrotational states.** Adam, I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems); Badalov, Kh.N.; Wawryszczuk, J.; Wagner, W.; Gromov, K.Ya.; Alikov, B.A.; Muminov, T.M. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 20p. (In Russian). Order Number DE90620914. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The properties of nonrotational states in odd nuclei of ytterbium with A=163-173 are discussed. A short review of experimental data for every nucleus separately is given. Equilibrium values of quadrupole and hexadecapole deformation parameters for one-quasiparticle states are discussed. The calculation results are compared with the experimental data. 91 refs.; 4 figs.; 8 tabs.

25054 (JINR-R–6-88-756) **^{146}Eu decay scheme and structure of ^{146}Sm excited states.** Adam, I. (Ceskoslovenska Akademie Ved, Rez (Czechoslovakia). Ustav Jaderne Fyziky); Dobesh, Ya.; Batsev, S.K. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 16p. (In Russian). Order Number DE90620950. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

On the basis of data on differential-integral coincidences the ^{146}Eu→^{146}Sm decay scheme is constructed. It consists of 68 levels, 22 of them have been introduced for the first time. Spins, parities and lg ft for excited levels of ^{146}Sm are determined. Within the model of interacting bosons in which proton and neutron bosons are distinguished, energies and quantum characteristics of excited levels of ^{146}Sm and reduced probabilities of E2-, M1-transitions are calculated. 19 refs.; 1 fig.; 5 tabs.

25055 (KFTI–88-8) **Tensor polarized target in the deuteron electrodisintegration.** Rekalo, M.P.; Gakh, G.I.; Rekalo, A.P. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 16p. (In Russian). Order Number DE90620937. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Consideration is given to results of analyzing polarization effects in exclusive electrodisintegration d-vector(e,e'p)n and d-vector(e,np)e' on tensor polarized deuteron target. Calculations were conducted in relativistic impulse approximation, providing for contributions of pole members in s-,t-,u-channels and modified contact member, providing for gauge invariance of j*d→np transition amplitude. Deuteron wave functions for Reid potentials with soft core, Paris potential and relativistic Buck-Gross wave functions were used. Relativistic impulse approximation provides satisfactory description of the data of Novosibirsk experiment on measuring asymmetry of d-vector(e,np)e' cross section of d-vector(e-vector,e'p)n process of tensor polarized deuteron target disintegration by nonpolarized and longitudinally polarized electrons is presented. Sensitivity of various asymmetries to the choice of deuteron wave function was investigated. It is shown that transverse and longitudinal asymmetries of d-vector(e,np)e' cross section depend sufficiently on behaviour of deuteron wave function at small distances. 34 refs.; 10 figs.; 1 tab.

25056 (LBL–28172) **Nuclear decay studies far-from-stability.** Firestone, R.B.; Nitschke, J.M.; Wilmarth, P.A.; Vierinen, K.S.; Chasteler, R.M.; Gilat, J.; Shihab-Eldin, A.A. Lawrence Berkeley Lab., CA (USA). Dec 1989. 40p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-8909247–7: ACS symposium on exotic nuclear spectroscopy, Miami Beach, FL (USA), 11-15 Sep 1989). Order Number DE90008666. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Nuclear decay studies far-from-stability are performed not merely to characterize new isotopes, but to establish an experimental footing for improving our theoretical understanding of nuclear structure and decay. Although progress has been made in explaining low-lying level structure for a broad range of nuclei, transition probabilities are not yet quantitatively understood. The ability to understand nuclei far-from-stability is important to astrophysics for extending r- and s-process calculations to unknown nuclei, and to nuclear engineering for decay-heat calculations. Finally, by studying nuclei far-from-stability, we probe extremes of both decay energy and proton-neutron ratios where unforeseen and important new nuclear properties may be exhibited. The decays of nearly 100 isotopes and isomers have been studied with the OASIS mass-separation facility on-line at the Lawrence Berkeley Laboratory SuperHILAC. These studies have concentrated on neutron-deficient nuclei with $55 \leq Z \leq 71$ up to A=157 and neutron-rich nuclei with $166 \leq A \leq 174$. The results of these experiments are combined in this paper with those from many other laboratories to provide insight into systematic trends of beta- and γ-ray transition probabilities near N=82. It is hoped that the smooth systematic trends in these transition probabilities will provide clues towards interpreting the underlying nuclear structure. Nuclei near N=82 and Z=64 are expected to be spherical and should be described by simple Shell Model considerations. Away from the shell closures, deformation sets in which should exhibit itself in the transition probabilities. The Z=64 shell closure is expected to disappear near N=78. The qualitative nature of these phenomena will be discussed.

25057 (ZfK–617) **Limits on heavy axion production from the reaction n(p,a)d.** Enghardt, W.; Kaun, K.H.; Prade, H.; Bluemlein, J.; Lanius, K. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1987. 6p. Order Number DE90620938. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A search has been made for the creation of shortlived axions in the isovector transition n(p,a)d decaying into e^+e^--pairs. The production of Peccei-Quinn axions can be excluded for $1.21 < m_a < 1.98$ MeV c^{-2} (90% CL). Limits on variant axion models are derived. (author).

25058 (ZfK–620) **Analysis of incomplete-fusion cross-section based on quasimolecular doorway state assumption.** Christov, C. (Inst. for Nuclear Research and Nuclear Energy, Sofia (Bulgaria)). Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1987. 8p. Order Number DE90620939. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The fusion cross-section is analysed within a reaction mechanism based on a quasimolecular doorway assumption. Applying the projection operator method general expressions for the average cross-section are derived in two opposite cases: (a) isolated doorway states, (b) overlapping doorway states. The obtained expressions exhibit a strong dependence on the entrance channel dynamics and also include a factor reflecting the influence of the final compound states. (author).

25059 (ZfK–642) **Kinematic relations in heavy-ion reactions.** Gippner, P. (Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic)); Kalpakchieva, R. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1988. 15p. (In Russian). Order Number DE90620905. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The present work gives a short overview of the non-relativistic kinematics of nuclear reactions derived on the basis of the conservation laws of energy and linear momentum. Section 2 contains kinematic relations valid for two-body reactions, sections 3 makes use of these relations to describe sequential fission as a special case of reactions with three particles in the exit channel. It is the aim of this work to comprise the kinematic formulae essential for planning of experiments, data analysis and critical examination of the obtained results. (author).

25060 (ZfK–659) **Berry phases and magnetic monopoles in the theory of rotations.** Muenchow, L. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1989. 10p. Order Number DE90620915. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

In adiabatic rotations Berry's phase is connected with signature-splitting, as follows from the semiclassical cranking model. In a three-dimensional rotation theory by projecting from S^3 to S^2 the internal top motion is described by a Dirac monopole and its quantization condition determines the signature dependence of the spectrum. (author).

25061 **Pion single-charge-exchange scattering and nuclear structure in deformed nuclei.** Bartel, J. (Theoretical and Medium Energy Physics Divisions, Los Alamos National Laboratories, Los Alamos, New Mexico 87545 (US)); Johnson, M.B.; Singham, M.K. *Annals of Physics (New York) (USA),* 196(1): 89-134 (15 Nov 1989).

Using a coupled-channel optical model, we consider pion single-charge-exchange observables for scattering from ^{165}Hc to its isobaric analog state in ^{165}Er. We use optical-model and Skyrme-force parameterizations that were determined independently, making this investigation free of any adjustable parameters. We find reasonably good agreement with the measured differential cross section for charge exchange on unoriented ^{165}Ho; for the orientation asymmetry $\vec{A}_s$ (transversely polarized ^{165}Ho compared to unoriented ^{165}Ho) we find a value that is small (2%) for scattering angle θ=0°. We show the sensitivity of the differential cross section and the orientation asymmetry to medium modifications of the pion-nucleon scattering amplitude; we also compare the neutron, proton, and transition densities obtained in constrained Hartree–Fock calculations to various *ansatze* used previously in the literature. In particular, we study the importance of pairing correlations, coupled channels, various Coulomb effects, the relative contributions of higher multipolarities in the density, and model dependence arising from the choice of the Skyrme interaction. © 1989 Academic Press, Inc.

25062 **Distortion of charmonium formation amplitude by deconfined environment.** Matsui, T. (Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, MA 02139 (US)). *Annals of Physics (New York) (USA),* 196(1): 182-208 (15 Nov 1989).

Dynamical origin of the J/ψ suppression in ultrarelativistic nucleus-nucleus collisions is studied focussing on the formation mechaniusm of heavy quark bound states. We first derive a formula for a charmonium production cross section based on the gluon fusion model taking into account the distortion of the charmonium formation amplitude due to the change of the final state interaction between $\bar{c}c$ in the presence of deconfined environment for a short period after the collision. The modification of the charmonium production cross section for the two-gluon fusion process is studied with this formula using a schematic harmonic oscillator model for the intermediate and final $\bar{c}c$ bound states. It is shown that in the fully deconfined medium the charmonium formation probability attenuates smoothly on a characteristic time scale which is expected from the semiclassical consideration for the "formation time" of bound states; while in partially deconfined medium the formation probability oscillates with the frequency corresponding to that of the bound state in such medium. Our result indicates that there is no threshold behavior in J/ψ suppression by the quark-gluon plasma formation and p_T dependence is much weaker than expected from a simple model calculation assuming threshold behavior. © Academic Press, Inc.

25063 **Supernovae and the hadronic equation of state.** Kahana, S.H. (Physics Department, Brookhaven National Laboratory, Upton, New York 11973 (USA)). *Annual Review of Nuclear and Particle Sciences (USA),* 39(1): 231-258 (1989). DOE Contract AC02-76CH00016.

Theoretical work on supernovae and equation of state for nuclear physics is reviewed. The items discussed are: (1) astrophysics of supernovae, (2) Skryme forces, (3) nuclear matter, (4) mean field theory, (5) quarks.(AIP)

25064 **Two-nucleon-transfer form factors in heavy rotational nuclei.** Bayman, B.F. (School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455 (USA)); Bernath, M.; Bes, D.R. *Physical Review, C (Nuclear Physics) (USA),* 41(2): 581-593 (Feb 1990).

We construct microscopic form factors for the simultaneous transfer of pairs of nucleons carrying angular momentum L=0 and 2 using the deformed cylindrical harmonic oscillator basis. We perform a detailed comparison with macroscopic form factors and we specialize the discussion to the vicinity of values of the angular velocity, particle number, and energy for which degeneracies occur. At these so-called "diabolic points" a nuclear manifestation of Berry's phases takes place.

6540 Radiation and Shielding Physics

Refer also to citation(s) 23912

25065 (JINR-R–3-88-394) **Small angle neutron scattering at pulsed neutron sources: solution of some experimental problems.** Bezzabotnov, V.Yu.; Ostanevich, Yu.M. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 14p. (In Russian). Order Number DE90620897. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to the Organizing Committee of the International conference on neutron scattering, 12-15 July 1988, Grenoble, France.

Investigations of the small angle neutron scattering (SANS) by the time-of-flight technique being carried out at pulsed neutron sources meet a number of specific experimental problems. Three of them (transformation of the observed intensity into scattering cross sections, determination of the detecting system dead-time and measurement of the effective thickness of a thin sample) are

solved by taking into account the features of the pulsed neutron source. 19 refs.; 4 figs.; 2 tabs.

6550 Medical Physics

Refer also to citation(s) 23619

25066 (ZfK–624) **A method for determining skin dose and the radiation composition in β/γ-mixed fields using 'thick' thermoluminescent detectors.** Sahre, P. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1987. 39p. (In German). Order Number DE90621701. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

For determining the skin dose in β/γ-fields of unknown composition normally thin detectors or combined dosimetric systems containing thick detectors have been used up to now. In the paper presented the first attempt to utilize completely the depth dose distribution in a thick, homogeneous TL-detector is proposed and investigated theoretically and experimentally. The method is based on the migration of a temperature front through the detector yielding a special glow curve. The shape of the glow curve and its location depends on the depth dose distribution. The computer aided unfolding of the glow curve using the superposition of standard glow curves is described. The results obtained are the skin dose in a eligible depth (less than the thickness of the detector) and the radiation components at the point of exposition. (author).

6560 Condensed Matter Physics

Refer also to citation(s) 23771, 23777, 23877, 23912, 23945, 24070, 24190, 24316, 25154

25067 (CONF-8909210–9) **Stopping power for protons in Al for the whole range of velocities.** Flores, F. (Universidad Autonoma de Madrid (Spain). Dept. de Fisica de la Materia Condensada); Arnau, A.; Echenique, P.M.; Ritchie, R.H. Oak Ridge National Lab., TN (USA). [1989]. 15p. Sponsored by U.S. DOE Energy Research; North Atlantic Treaty Organization. DOE Contract AC05-84OR21400. From 12. Werner Brandt international workshop on charged particle penetration phenomena; San Sebastian (Spain); 4-7 Sep 1989. Order Number DE90008558. Available from NTIS, PC A03/MF A01 - OSTI.

The electronic stopping power of aluminium metal for protons has been calculated with explicit inclusions of the different proton charge states inside the medium. The total stopping power is obtained by adding to the calculated stopping power of each charge state, the energy loss associated with the electronic exchange processes. Good agreement is obtained between our first principles calculation and the available experimental data. 12 refs., 5 figs.

25068 (CONF-8909210–10) **Radiative electron capture by channeled ions.** Pitarke, J.M. (Universidad del Pais Vasco, Bilbao (Spain). Zientzi Fakultatea); Ritchie, R.H. Oak Ridge National Lab., TN (USA). [1989]. 16p. Sponsored by U.S. DOE Energy Research; National Science Foundation; Universidad del Pais Vasco. DOE Contract AC05-84OR21400. From 12. Werner Brandt international workshop on charged particle penetration phenomena; San Sebastian (Spain); 4-7 Sep 1989. Order Number DE90008570. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Considerable experimental data have been accumulated relative to the emission of photons accompanying electron capture by swift, highly stripped atoms penetrating crystalline matter under channeling conditions. Recent data suggest that the photon energies may be less than that expected from simple considerations of transitions from the valence band of the solid to hydrogenic states on the moving ion. We have studied theoretically the impact parameter dependence of the radiative electron capture (REC) process, the effect of the ion's wake and the effect of capture from inner shells of the solid on the photon emission probability, using a statistical approach. Numerical comparisons of our results with experiment are made. 13 refs., 6 figs.

25069 (DOE/ER/13227–6) **Pulsed laser photothermal spectroscopy of liquids and solids: Progress report, April 1, 1987–September 25, 1989.** Eyring, E.M. Utah Univ., Salt Lake City, UT (USA). 25 Sep 1989. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER13227. Order Number DE90008642. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Published papers have compared the advantages of piezoelectric and optical detection of photoacoustic signals in sample liquids and have demonstrated the superior capabilities of thermal lens measurements on time scales as short as a few hundred nanoseconds. Computer programs have been developed to compare theoretical and experimental photoacoustic pulse shapes in liquids with a view to determining triplet state quantum yields and radiationless decay lifetimes with greater accuracy. Non-radiative quantum yields of 1.0, 0.9 and 0.5 have been measured for non-aqueous solutions of Crystal Violet, Evan's Blue and Nile Blue A respectively. Pulsed photothermal radiometry experiments have yielded thermal diffusivity data for a room temperature molten salt system. Microphonic photoacoustic signals obtained by illuminating solid samples with synchrotron x-rays have been enhanced with volatile liquids, and the results have been compared with theory.

25070 (DOE/ER/13847–1) **[Some basic research problems related to energy]: Annual technical progress report, February 1989–February 1990.** Cohen, E.G.D. Rockefeller Univ., New York, NY (USA). Feb 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER13847. Order Number DE90008554. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper discusses work on correlation functions in hard sphere fluids, colloidal suspension and Lorentz lattice gas cellular automata. (LSP)

25071 (JINR-E–17-88-822) **On the explanation of anomalies in inelastic neutron scattering by high-T_c superconductors.** Plakida, N.M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics); Aksenov, V.L.; Drechsler, S.L.; Rakauskas, R.J.; Stamenkovic, S.; Galbaatar, T. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 12p. Order Number DE90620561. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The nuclear inelastic neutron scattering on highly anharmonic vibrations of oxygen ions in high-T_c superconductors is considered. In the framework of a pseudo-spin model associated with rotational vibrations of O-Cu-O molecules both coherent and incoherent scattering cross-sections are evaluated. A possible explanation of experimentally observed anomalous temperature and angular dependences of inelastic neutron scattering intensity in high-T_c superconductors LSCO and YBCO is proposed. 18 refs.; 3 figs.

25072 (JINR-R–4-88-693) **New approach to the dynamical diffraction theory in the case of three-dimensional perfect crystal.** Ignatovich, V.K. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 19p. (In Russian). Order Number DE90620563. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The reflection and transmission amplitudes of a perfect crystal of finite thickness, all possible orders of diffractions being taken inot account, are calculated with the help of pure algebraic method. The recursive relations and supposition of the diffraction from crystalline plane parllel to the entrance surface being known are in the basis of the method. For the illustration the total reflection, one-wave Bragg reflection and two-wave Laue diffraction of neutrons from a tetragonal crystal with one atom in an elementary cell are calculated. The results of calculations coincide with the results of the well known dynamical diffraction theory. The new back reflection effect is predicted. 11 refs.

25073 (JINR-R–14-88-571) **Influence of high energy radiation on critical parameters of superconducting ceramics $YBa_2Cu_3O_7$.** Aleksandrov, A.S. (Moskovskij Gosudarstvennyj Univ., Moscow (USSR)); Astapov, A.A.; Drobin, V.M. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 10p. (In Russian). Order Number DE90620562. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to Fiz. Tverd. tela.

Critical parameters T_0 and J_0 of superconducting ceramics $YBa_2Cu_3O_7$ have been measured after irradiation at 300 K by 0.66, 8.09 GeV protons and by ^{12}C nuclei with 3.65 GeV/nucleon energy.

Maximum irradiation dose was $3x10^8$ J/kg (Gy). Strong radiation degradation of T_0 and J_0 was explained by spontaneous recombination of point defects in displacement zones, connected with availability of thermally activating unregulated regions, which lead to electron localization and infringement of Josephson contacts between ceramics grains. Results of $T_0(D)$ and $J_0(D)$ measurement are compared with analogous dependences for reactor spectrum neutrons (E>0.1 MeV) and ions $^4He(E_\alpha=6.7$ MeV). The obtained experimental results can favor the the understanding of mechanism of higher temperature superconductivity. 14 refs.; 5 figs.; 3 tabs.

25074 (LA-UR–90-839) **Diamond: A high power optical material.** Singer, S. Los Alamos National Lab., NM (USA). [1990]. 19p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-900368–3: International conference on optical science and engineering, Hague (Netherlands), 12-16 Mar 1990). Order Number DE90008941. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Single-crystal chemically/isotopically pure synthetic diamond operated at low temperature offers an unusual opportunity for a small transparent optic that may transmit as much as tens to hundreds of megawatts of light, even in the presence of high peak power in the light beam. This property stems from the probable very low absorption of light in such material and the nature of the phonon energy transport at low temperature. 10 refs., 6 figs., 1 tab.

25075 (ZfK–619) **Theoretical and experimental investigation of the thermal extension in targets used for the application of thermography in beam diagnostics.** Schmidt, D. (Technische Univ., Dresden (German Democratic Republic). Sektion Physik); Buettig, H.; Jahn, U. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1987. 14p. (In German). Order Number DE90620569. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The temperature distribution in targets is calculated and discussed for several beam profiles. Estimations for target calculation are given and checked experimentally which are used for beam profile monitors based on thermography. (author).

25076 (ZfK–627) **Investigations to problems of the implantation metallurgy.** Rauschenbach, B. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1987. 70p. (In German). Order Number DE90620570. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Basing on processes and effects caused ion implantation of metals a review is given about the problems of the implantation metallurgy. Techniques of high-fluence ion implantation and ion beam mixing are generally confined. These techniques change the structure and the chemical composition in the near of the surface of metals. The application of these methods is demonstrated on series of examples. (author).

25077 (ZfK–630) **Amorphization of metals by ion implantation and ion beam mixing.** Rauschenbach, B.; Heera, V. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1988. 29p. Order Number DE90620571. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Amorphous metallic systems can be formed either by high-fluence ion implantation of glassforming species or by irradiation of layered metal systems with inert gas ions. Both techniques and experimental examples are presented. Empirical rules are discussed which predict whether a given system can be transformed into an amorphous phase. Influence of temperature, implantation dose and pre-existing crystalline metal composition on amorphization is considered. Examples are given of the implantation induced amorphous structure, recrystallization and formation of quasicrystalline structures. (author).

25078 (ZfK–648) **Stopping power and range tables for low and medium energy ions with $Z \leq 16$.** Henniger, J. (Technische Univ., Dresden (German Democratic Republic). Sektion Physik); Enghardt, W.; Gippner, P. Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic). 1988. 34p. Order Number DE90620572. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Stopping powers and range in materials being important in the construction and operation of gaseous particle detectors are tabulated for projectiles of atomic numbers $1 \leq Z \leq 16$ and energies between 0.05 and 40 MeV/amu. The method of calculation is briefly outlined. (author).

25079 Renormalization of Aubry-Mather Cantor sets. Veerman, J.J.P. (Rockefeller Univ., New York, NY (USA)); Tangerman, F.M. *Journal of Statistical Physics (USA)*, 56(1-2): 83-98 (Jul 1989). DOE Contract AC02-83ER13044.

Let f be a two-dimensional area-preserving twist map. Given an irrational rotation number ω in the rotation interval of f, there is an invariant recurrent set on which f preserves the circular ordering and which has rotation number ω. For large nonlinearity, the parameter regime the authors are interested in, this set is a Cantor set. They show that well-ordered (minimizing) sets with rotation numbers close to ω are exponentially close to the Cantor set under study. The detailed configuration of well-ordered (minimizing) sets is universal and depends on one parameter, namely the Lyapunov coefficient of the Cantor set. There is a quantitative correspondence between this and similar behavior in the noninvertible circle map.

25080 Phase space density representations in fluid dynamics. Ramshaw, J.D. (EG and G Idaho, Idaho Falls (USA)). *Journal of Statistical Physics (USA)*, 56(1-2): 149-158 (Jul 1989). DOE Contract AC07-76ID01570.

Phase space density representations of inviscid fluid dynamics were recently discussed by Abarbanel and Rouhi. Here it is shown that such representations may be simply derived and interpreted by means of the Liouville equation corresponding to the dynamical system of ordinary differential equations that describes fluid particle trajectories. The Hamiltonian and Poisson bracket for the phase space density then emerge as immediate consequences of the corresponding structure of the dynamics. For barotropic fluids, this approach leads by direct construction to the formulation presented by Abarbanel and Rouhi. Extensions of this formulation to inhomogeneous incompressible fluids and to fluids in which the state equation involves an additional transported scalar variable are constructed by augmenting the single-particle dynamics and phase space to include the relevant additional variable.

25081 The wetted solid—A generalization of the Plateau problem and its implications for sintered materials. Salamon, P. (Department of Mathematical Sciences, San Diego State University, San Diego, California 92182 (USA)); Bernholc, J.; Berry, R.S.; Carrera-Patino, M.E.; Andresen, B. *Journal of Mathematical Physics (New York) (USA)*, 31(3): 610-615 (Mar 1990).

A new generalization of the Plateau problem that includes the constraint of enclosing a given region is introduced. Physically, the problem is important insofar as it bears on sintering processes and the structure of wetted porous media. Some primal and dual characterizations of the solutions are offered and aspects of the problem are illustrated in one and two dimensions in order to clarify the combinatorial elements and demonstrate the importance of numerous local minima.

25082 Tricritical trails on a square lattice with impenetrable linear boundary: Computer simulation and analytic bounds. Chang, I.S. (Department of Physics and Astronomy, University of Rochester, Rochester, New York, 14627-0011 (USA)); Meirovitch, H.; Shapir, Y. *Physical Review, A (General Physics) (USA)*, 41(4): 1808-1822 (15 Feb 1990).

Using the scanning simulation method we study self-attracting trails (with energy ϵ per intersection) terminally attached to an impenetrable linear boundary on a square lattice, at their tricritical collapse transition. We obtain (with 95% confidence limits) that the partition function exponents are $\gamma_{11'}=0.634\pm0.025$ (for trails with one end attached to the boundary) and $\gamma_{11'}=-0.44\pm0.02$ (both ends are attached). These results differ significantly from the exact values ($8/7\cong1.143$ and $4/7\cong0.571$), respectively, derived by Duplantier and Saleur (DS) [Phys. Rev. Lett. 59, 539 (1987)] for self-avoiding walks (SAW's) on a dilute hexagonal lattice at the *FTHETA'* point. Our values are within the error bars of the numerical estimates of Seno and Stella for SAW's on the same lattice at the *FTHETA* point. The crossover exponent is calculated in several ways and the various results approximately converge to $\phi_t\cong0.71$ if

corrections to scaling are taken into account. This value is significantly larger than the DS exact value for the *FTHETA'* point $\phi=3/7\cong0.43$; it is also larger than recent numerical estimates of ϕ_t for SAW's at the *FTHETA* point. These results suggest that tricritical trails are in a different universality class than SAW's in both the *FTHETA* and the *FTHETA'* point. The results for the shape exponent ν_t are consistent with the DS value $4/7\cong0.571$.

25083 Nearest-neighbor distribution functions in many-body systems. Torquato, S. (Department of Mechanical and Aerospace Engineering and Department of Chemical Engineering, North Carolina State University, Raleigh, North Carolina 27695-7910 (USA)); Lu, B.; Rubinstein, J. *Physical Review, A (General Physics) (USA),* 41(4): 2059-2075 (15 Feb 1990).

The probability of finding a nearest neighbor at some given distance from a reference point in a many-body system of interacting particles is of importance in a host of problems in the physical as well as biological sciences. We develop a formalism to obtain two different types of nearest-neighbor probability density functions (*void* and *particle* probability densities) and closely related quantities, such as their associated cumulative distributions and conditional pair distributions, for many-body systems of *D*-dimensional spheres. For the special case of impenetrable (hard) spheres, we compute low-density expansions of each of these quantities and obtain analytical expressions for them that are accurate for a wide range of sphere concentrations. Using these results, we are able to calculate the mean nearest-neighbor distance for distributions of *D*-dimensional impenetrable spheres. Our theoretical results are found to be in excellent agreement with computer-simulation data.

25084 Formalism for the calculation of local elastic constants at grain boundaries by means of atomistic simulation. Kluge, M.D. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439 (US)); Wolf, D.; Lutsko, J.F.; Phillpot, S.R. *Journal of Applied Physics (USA),* 67(5): 2370-2379 (1 Mar 1990). DOE Contract W-31-109-ENG-38.

A new formalism for use in atomistic simulations to calculate the full local elastic-constant tensor in terms of local stresses and strains is presented. Results of simulations on a high-angle (001) twist grain boundary are illustrated, using both a Lennard–Jones potential for Cu and an embedded-atom potential for Au. The two conceptionally rather different potentials show similar anomalies in all elastic constants, confined to within a few lattice planes of the grain boundary, with an especially dramatic reduction in the resistance to shear parallel to the grain-boundary plane. It is found that the primary cause of the anomalies is the atomic disorder near the grain boundary, as evidenced by the slice-by-slice radial distribution functions for the inhomogeneous interface system.

25085 Relations between elastic constants C_{ij} and texture parameters for hexagonal materials. Li, Y. (Ames Laboratory, Iowa State University, Ames, Iowa 50011 (US)); Thompson, R.B. *Journal of Applied Physics (USA),* 67(5): 2663-2665 (1 Mar 1990). DOE Contract W-7405-ENG-82.

Ultrasonic techniques have recently been applied to the texture characterization in polycrystalline aggregates of hexagonal crystals. The basis of this application lies in the relations between the elastic constants $\bar{C}_{ij}$ of the aggregates, which can be inferred from ultrasonic wave velocity measurements, and the orientation distribution coefficients. This communication presents such relations for aggregates which possess orthotropic material symmetry and hexagonal crystal symmetry for Voigt, Reuss, and Hill averaging methods in a unified and concise representation.

25086 Layer Korringa-Kohn-Rostoker technique for surface and interface electronic properties. MacLaren, J.M. (Theoretical Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (USA)); Crampin, S.; Vvedensky, D.D.; Pendry, J.B. *Physical Review, B: Condensed Matter (USA),* 40(18): 12164-12175 (15 Dec 1989).

A technique is presented for embedding planar defects such as interfaces or surfaces in an otherwise perfect crystal. The method is a layer Korringa-Kohn-Rostoker scheme, in which a solid containing the defect is first partitioned into layers of atoms. The scattering properties of each layer are calculated in a partial-wave basis set, using the two-dimensional symmetry assumed to be present in each layer. The layers are subsequently coupled together, in a plane-wave basis, to form a solid. The self-consistent equations for the scattering matrices of semi-infinite bulk regions embedding the defect are solved iteratively, removing the constraint of three-dimensional translational symmetry. Within this formalism, "supercell" and "slab" boundary conditions can also be applied with no extra difficulty. The approach is illustrated in detail for a twin fault in aluminum, for which the microscopic origins of the stacking-fault properties are discussed. Changes in local symmetry and the resulting hybridization of electronic states explain the observed perturbations in the stacking-fault electronic structure.

25087 Layer Korringa-Kohn-Rostoker theory for close-spaced planes of atoms. MacLaren, J.M. (Theoretical Division, MS-B262, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (USA)); Crampin, S.; Vvedensky, D.D. *Physical Review, B: Condensed Matter (USA),* 40(18): 12176-12182 (15 Dec 1989).

Layer Korringa-Kohn-Rostoker (LKKR) approaches that calculate interlayer scattering using a plane-wave basis set cannot treat systems in which the interplanar spacing becomes small. This problem is most acute at band energies at which electronic lifetimes are long and the scattering strong. Taking a face-centered-cubic material as an example, solutions for the simplest of grain boundaries, the $\Sigma5$ tilt, requires the stacking together of (210) planes. The planar spacing for this system is too small to allow the conventional LKKR methods to be applied. We estimate needing over 500 plane waves to converge the interlayer scattering in this case. We describe here a solution to layer coupling that allows for this situation. The technique optimizes the sizes of the angular momentum and plane-wave basis sets and thus provides an important extension to LKKR schemes. The ideas developed can be easily applied to both low-energy electron diffraction and photoemission.

25088 Electronic response in a one-dimensional nonlinear lattice. Wan, Y. (Ames Laboratory-U.S. Department of Energy and Department of Physics, Iowa State University, Ames, Iowa 50011-3020 (US)); Soukoulis, C.M. *Physical Review, B: Condensed Matter (USA),* 40(18): 12264-12270 (15 Dec 1989). DOE Contract W-7405-ENG-82.

We study electronic response in a one-dimensional nonlinear lattice in terms of a transmission problem where the nonlinear Schroedinger equation of the tight-binding form is considered to describe the motion of the electrons. We introduce an area-preserving nonlinear mapping for the transmission problem. We then analyze this mapping in the context of nonlinear dynamical theory, and discuss the results in terms of physical quantities describing the transmission process. We show a "phase diagram" in terms of the electronic energy and nonlinear coupling constant for the solutions which contribute to the transmission. We also calculate the transmission coefficients as functions of the nonlinear coupling constant. Our results demonstrate how interesting properties, such as multistability and noise, occur in the electronic response of our problem. Several physical models involving electronic or optical processes are considered as systems that might be relevant to our study.

25089 Electron paramagnetic resonance instrument with superconductive cavity. Jasper, L.J. To Department of the Army, Washington, DC (USA). USA Patent Application 7-437,401. 16 Nov 1989. 16p. Available from NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

The EPR instrument includes an X band klystron used to generate microwave power that is transmitted to a superconductive waveguide cavity resonator. The cavity is placed between the pole pieces of a large d-c magnet and small a-c magnetic coils energized by a modulation signal source. A microwave crystal detector detects RF energy emitted from the cavity. The detector output is amplified, rectified and filtered in a phase sensitive filter that uses the modulation signal source as a reference. The resultant signal is recorded by an amplitude vs. time recorder. The superconductive cavity includes an inner wall of high-temperature superconductive material, a liquid coolant and an insulating sleeve that passes through the cavity. The specimen to be analyzed is placed in the sleeve.

6561 Superconductivity

Refer also to citation(s) 23907, 23910, 23946, 23954, 23963, 23970, 23974, 23978, 24194, 25073

25090 (JINR-D-14-88-667) **A μSR-investigation of the mixed state of the high-T_c superconductor $HoBa_2Cu_3O_{7-\delta}$.** Grebinnik, V.G. (Joint Inst. for Nuclear Research, Dubna (USSR)); Duginov, V.N.; Gurevich, I.I. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 6p. (In Russian). Order Number DE90620802. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The high-T_c superconductor $HoBa_2Cu_3O_{7-\delta}$ has been invesigated by the μSR-method in the magnetic field 0-1200 Oe in the temperature interval 10-100 K. It was established, that 80% of the sample volume is experienced by the diamagnetic shielding effect. The mixed state in the superconductor is formed in the external magnetic field > 20 Oe at 30 K. The magnetic penetration depth λ as a function of the temperature was obtained. Its value at 30 K is about 1300 A. 5 refs.; 4 figs.; 1 tab.

6570 Theoretical and Mathematical Physics

Refer also to citation(s) 24023, 24307, 24832, 24935, 25079, 25080, 25081

25091 (CSIR-TWISK-TR-441) **Adaptive mesh refinement for finite element solutions of an integral equation in quantum scattering.** Eyre, D. (Council for Scientific and Industrial Research, Pretoria (South Africa). National Research Inst. for Mathematical Sciences); Wright, C.J. Council for Scientific and Industrial Research, Pretoria (South Africa). National Research Inst. for Mathematical Sciences. Feb 1986. 25p. Available from the National Research Institute for Mathematical Sciences, PO Box 395, Pretoria, 0001, South Africa. Available from the National Research Institute for Mathematical Sciences, PO Box 395, Pretoria, 0001, South Africa.

Finite element methods have wide applicability for solving many types of equations. An intrinsic property of the finite element method is the 'freedom' in the choice of mesh. The correct choice of mesh can improve the accuracy of the numerical solution. Adaptive mesh refinement (AMR) in finite element solutions of the two-body Lippmann-Schwinger integral equation was investigated. Approximate solutions were obtained from both Galerkin and collocation projection methods using cubic spline approximants. The accuracy of the approximate solutions using a small number of basis functions were improved with an AMR that employed a combination of arc length and total curvature. For some combinations of arc length and total curvature, the nodal points oscillated and therefore the solution did not converge. This result serves as a warning against the blind application of adaptive mesh techniques. However, in those examples were convergence occurred, the result obtained was better than the preliminary solution. 12 refs., 3 figs., 5 tabs.

25092 (DOE/ER/40282-T1) **A new determination of the fine-structure constant: Final report.** National Inst. of Standards and Technology (NML), Gaithersburg, MD (USA). Electricity Div. [1989]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AI01-86ER40282. Order Number DE90008800. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This report, submitted by the Electricity Division of NIST, is to summarize the work performed under contract DE-AIO1-86ER40282 and represents a new experimental determination of the fine-structure constant α, to the accuracy of 3.7 parts in 10^8 (0.037 parts per million or ppm). The success of this experiment enabled the unequivocal testing of quantum electrodynamic theory (QED) to the same level of accuracy through the comparison of experimental and theoretical values of QED dependent quantities. These are the anomalous magnetic moment of the electron, a_e, the hyperfine splittings in muonium and positronium, and various Lamb shifts in hydrogen and helium. In view of the importance of quantum electrodynamics to our understanding of atomic, molecular, and particle physics, such critical comparisons have immense potential for confirming QED.

25093 (JINR-18-88-603) **Superheterodyne three-wave detection of gravitation waves.** Pisarev, A.F.; Pisareva, S.A. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 6p. (In Russian). Order Number DE90620465. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to the Organizing Committee of the 3. School on Research Automatization in Nuclear Physics and Astrophysics, Nal'chik, September 1988.

A superheterodyne method of mutual transformation of wave energies in the non-linear three-wave process involving a gravitational wave is considered. A flexible possibility of Transferring the great external gain coefficient from an electromagnetic or acoustic wave to the gravitation one is shown. It can facilitate generation and detection of this wave. 17 refs.

25094 (JINR-E-2-88-653) **The addition theorem for 4-velocities.** Strel'tsov, V.N.; Strokovski, E.A. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 6p. Order Number DE90620462. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The addition theorem for 4-velocities is obtained. It is shown that the time-like component of a relative 4-velocity of two particles is defined by a relativistic invariant quantity, namely, by the scalar product of their 4-velocities. The modulus square of the spatialcomponent of the relative 4-velocity, i.e. $-\vec{u}_{12}-^2$, is just a scalar product (double contraction) of the corresponding skew products of initial 4-velocities. Using the $-\vec{u}_{12}-$, the relativistic kinetic equation is presented in the explicitly Lorentz-invariant form. Some application of the relative 4-velocity in high energy physics is dicussed. 8 refs.

25095 (JINR-E-2-88-678) **Quantum mechanics in Riemannian space-time: General covariant Schroedinger equation with relativistic corrections.** Tagirov, Eh.A. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 12p. Order Number DE90620448. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Teor. Mat. Fiz.

The asymptotics for c^{-2} (c being the velocity of light) of the theory of a complex scalar field in the Riemannian space-time and external electromagnetic field is considered. The general-covariant Schroedinger equation with relativistic corrections for a scalar particle in external gravitational and electromagnetic fields is obtained for the case of normal Gaussian systems of reference. Account of the geometric variation of the spatial volume element along the geodesics of the system of reference leads to a Hamiltonian which is (asymptotically) self-adjoint with respect to the standard scalar product. This fact is considered as a ground for the Born interpretation of the wave functions. 7 refs.

25096 (JINR-E-4-88-688) **A kicked quantum system including the continuum.** Milek, B. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 11p. Order Number DE90620449. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The behaviour of a quantum particle in a separable one-term potential with three-dimensional form factor is investigated under the influence of an external force which alters the potential strength periodically or quasiperiodically. The unperturbed system possesses one bound state and a continuum of scattering states which has treated almost analytically. First numerical results, fully including the emission channel, indicate, for certain parameter combinations with commensurate or incommensurate frequency ratios, either a regular or an irregular dynamical behaviour of the system. 17 refs.; 3 figs.

25097 (JINR-E-5-88-623) **On the solution of the inverse scattering problem on the halfaxis.** Zhidkov, E.P. (Joint Inst. for Nuclear Research, Dubna (USSR)); Egikyan, R.S. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 7p. Order Number DE90620450. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The inverse scattering problem (ISP) of Quantum Mechanics on the halfaxis is investigated. The presentation of potential via scattering data in the closed integral form is given. A fundamental tool of the study is the Fourier transform. 10 refs.

25098 (JINR-E-5-88-700) **Algebras of observables of the CCR.** Senf, P. Joint Inst. for Nuclear Research, Dubna (USSR).

Lab. of Theoretical Physics. 1988. 12p. Order Number DE90620442. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The *-algebra of canonical commutation relations with infinite many degrees of freedom is studied on a dense domain. It is shown that it satisfies condition I_0'. 2 refs.

25099 (JINR-R-2-88-375) **Contemporary view on the theory of relativity origin.** Strel'tsov, V.N. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 4p. (In Russian). Order Number DE90620443. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The opinion is expressed that the prerequisites of construction of foundations for theory of relativity were the introduction of analogy between transformations of space and time coordinates (W.Voigt, 1887) and suggestion that the length of material bodies changes as they are moving (G.FitzGerald, 1889). It is noted that the introduction of Lorentz-FitzGerald contraction to interprete the negative result of Michelson-Morley experiments is due to inaccuracy of calculation of time of light propagation along the transverse arm of interferometer. 10 refs.

25100 (JINR-R-2-88-668) **Capture and confinement of solitons in nonlinear integrable systems.** Mel'nikov, V.K. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 6p. (In Russian). Order Number DE90620444. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Some nonlinear integrable systems were found to have solutions describing solitons that come from infinity and then are captured into oscillatory regimes. These solutions were obtained by the inverse scattering method for the one-dimensional Schroedinger operator on a straight line. The obtained results are relevant to some problems of hydrodynamics, plasma physics, solid state physics, etc. 2 refs.

25101 (JINR-R-2-88-724) **About virial expansion in multiple production theory.** Mandzhavidze, I.D. (Tbilisskij Gosudarstvennyj Univ., Tbilisi (USSR)). Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 14p. (In Russian). Order Number DE90620451. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The method for computer calculations of the cross sections of multiple production in terms of expansion over inverse powers of produced particle production density are given. The method can be useful in the region of asymptotical values of multiplicity. 6 refs.

25102 (JINR-R-2-88-725) **Nonstandard approach to the previous perturbation theory.** Mandzhavidze, I.D. (Tbilisskij Gosudarstvennyj Univ., Tbilisi (USSR)). Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 16p. (In Russian). Order Number DE90620452. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

For the definition of functional measure it is proposed that the states built on different trajectories in a functional space belong to the orthogonal Hilbert spaces. It is shown that this definition of functional integral measure for the gauge theories gives the standard perturbation theory. Necessity of extra selection rules in case of nonabelian gauge theories is also demonstrated. 4 refs.

25103 (JINR-R-2-88-778) **Background connection, a necessary object in general relativity.** Chernikov, N.A. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 14p. (In Russian). Order Number DE90620463. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to the Organaizing committee of the 7. Soviet gravitational conference Modern theoretical and experimental problems of relativity and gravitation, Erevan, October, 1988.

It is shown that in Einstein's theory of gravity (ETG), an important geometrical object has been lost while introducing the concept of the energy pseudotensor of the gravitational field. This object found at present is the affine connection, on whose background the gravitational field should be considered. That loss made the ETG contradictory to Einstejn's general principle of relativity. To remove the contradiction, it suffices to introduce a primitive affine connection. However, nothing prevents us from considering the background object being not primitive but an arbitrary affine connection without torsion. Under this condition we may rather easily vary both the gravitational field g_{ab} and the affine connection independent of g_{ab}. Owing to restoration of the lost object, the ETG becomes a perfectly geometrical theory in which all physical objects are geometrical ones. 8 refs.

25104 (JINR-R-4-88-634) **Relativistic transformations for the moment of the magnetic dipole.** Frank, I.M. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 8p. (In Russian). Order Number DE90620464. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

For several years the quesation was under dicussion of an electric dipole moment acquired by a magnetic dipole moving in a medium. Now it is accepted that for the relation between the magnetic and electric moment in a medium the same relativistic formula as for a magnetic dipole moving in a vacuum can be used. Consideration undertaken in this paper of a closed current loop moving in a vacuum contains and additional argument in favor of the above statement. In the limit case this loop is equivalent to a moving magnetic dipole. The comparison of the obtained results with the known data concerning the electric dipole has shown that in the case of medium there are no reasons whatsoever to change relativistic transformation formulas. 5 refs.; 1 fig.

25105 (JINR-R-5-88-649) **Informationally open systems and reduction of wave packet.** Kostenko, B.F. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 18p. (In Russian). Order Number DE90620453. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Teor. Mat. Fiz.

For description of evolution of quantum systems when information about them is transmitted to the physical surrounding, the Schroedinger equation with stochastic parameters (Schroedinger-Stratonovich equation) is suggested. In the framework of the physical concept of informaly open systems a dynamical theory of measuring process is elaboarted for the case of strong and weak interactions of a macroscopic measuring apparatus. The connection between this theory and classical stochastic dynamics as well as transition to the quantum stochastic fields are discussed. It is shown that both individual and statistical descriptions of the system is possible. 9 refs.

25106 (JINR-R-5-88-782) **On operators associated with the product of solutions of two Sturm-Liouville problems.** Christov, E.Ch. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 15p. (In Russian). Order Number DE90620454. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Expansion formulae over the product of the solutions of two self-adjoint Sturm-Liouville problems are obtained. An explicit form of the operators for which these formulae are expansions of the unit is constructed. 9 refs.

25107 (LA-UR-90-537) **Integrability and chaos in nonlinearly coupled optical beams.** David, D. Los Alamos National Lab., NM (USA). [1989]. 20p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-8910365-1: C.R.M. workshop on Hamiltonian Systems: transformation groups and spectral transform methods, Montreal (Canada), 20-26 Oct 1989). Order Number DE90007540. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper presents a study, using dynamical systems methods, of the equations describing the polarization behavior of two nonlinearly coupled optical beams counterpropagating in a nonlinear medium. In the travelling-wave regime assumption, this system possesses a Lie-Poisson structure on the manifold $C^2 \times C^2$. In the case where the medium is assumed to be isotropic, this system exhibits invariance under the Hamiltonian action of two copies of the rotation group, S^1, and actually reduces to a lower-dimensional system on the two-sphere, S^2. We study the dynamics on the reduced space and examine the structure of the phase portrait by determining the fixed points and infinite-period homoclinic and heteroclinic orbits; we concentrate on presenting some exotic behaviour that occurs when some parameters are varied, and we also show special solutions associated with some of the above-mentioned orbits. Last, we demonstrate the existence of complex

dynamics when the system is subject to certain classes of Hamiltonian perturbations. To this end, we make use of the Melnikov method to analytically show the occurrence of either horseshoe chaos, or Arnold diffusion. 19 refs.

25108 (UCRL–101560) **Scattering sources: A spherical harmonics expansion.** Garelis, E. Lawrence Livermore National Lab., CA (USA). 19 Jul 1989. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900418–8: International conference on the physics of reactors: operation, design and computation, Marseilles (France), 23-26 Apr 1990). Order Number DE90008724. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Glam code solves the two dimensional azimuthally symmetric steady equation of transfer for the energy density, flux, and the pressure tensor. The code calculates the intensity along a given ray and then using a numerical quadrature scheme calculates the various moments. For problems with isotropic scattering it is a simple matter to include the scattering. In this note we derive the precise dependence of the flux and the pressure tensor on the anisotropic scattering. With these relationships established we can then include these scattering sources in the Glam code to account for the anisotropic scattering. 4 refs.

25109 (UCRL–101624) **Radiation mechanisms for microscopic relativistic electron beams.** Moran, M.J. Lawrence Livermore National Lab., CA (USA). Sep 1989. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8909210–11: 12. Werner Brandt international workshop on charged particle penetration phenomena, San Sebastian (Spain), 4-7 Sep 1989). Order Number DE90008721. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Relativistic electron beams are used to generate intense beams of coherent photons from the microwave to the x-ray spectral regions. The brightest sources of visible and x-ray radiation currently are based on synchrotron radiation from multi-GeV storage-ring electron beams. Continuing progress with techniques for generating microscopic-diameter (d < 1000 Å) relativistic (E < 1 MeV) electron beams is making feasible new kinds of photon sources. These sources are based on diffraction radiation and they will have high radiation efficiencies for visible photon energies. With further improvements in electron beam quality, these sources might eventually be extended into the x-ray spectral region. 12 refs., 7 figs.

25110 Cyclic quantum evolution and Aharonov-Anandan geometric phases in SU(2) spin-coherent states. Layton, E. (Department of Chemistry, University of Kansas, Lawrence, Kansas 66045 (US)); Huang, Y.; Chu, S. *Physical Review, A (General Physics) (USA),* 41(1): 42-48 (1 Jan 1990).

We show that cyclic quantum evolution can be realized and the Aharonov-Anandan (AA) geometric phase can be determined for any spin-*j* system driven by periodic fields. Two methods are extended for the study of this problem: the generalized spin-coherent-state technique and the Floquet quasienergy approach. Using the former approach, we have developed a *generalized* Bloch-sphere model and presented a SU(2) Lie-group formulation of the AA geometric phase in the spin-coherent state. We show that the AA phase is equal to *j* times the solid angle enclosed by the trajectory traced out by the tip of a generalized Bloch vector. General analytic formulas are obtained for the Bloch vector trajectory and the AA geometric phase in terms of external physical parameters. In addition to these findings, we have also approached the same problem from an alternative but complementary point of view without recourse to the concept of coherent-state terminology. Here we first determine the Floquet quasienergy eigenvalues and eigenvectors for the spin-*j* system driven by periodic fields. This in turn allows the construction of the time-evolution propagator, the total wave function, and the AA geometric phase in a more general fashion.

25111 New method in time-dependent quantum scattering theory: Integrating the wave function in the interaction picture. Zhang, J.Z.H. (Department of Chemistry, University of California, Berkeley, CA (US)—Materials and Chemical Science Division, Lawrence Berkeley Laboratory, Berkeley, California 94720 (US)). *Journal of Chemical Physics (USA),* 92(1): 324-331 (1 Jan 1990).

A new approach for solving the time-dependent wave function in quantum scattering problem is presented. The conventional wave packet method, which directly solves the time-dependent Schroedinger equation, normally requires a large number of grid points since the Schroedinger picture wave function both travels and spreads in time. Also, since the Schroedinger picture wave function oscillates in time with frequency $\omega \approx E/\hbar$, a very small time increment is required to integrate the Schroedinger equation, especially for high energy collisions. The new method presented in this paper transforms the Schroedinger picture wave function into the interaction picture and carries out the integration in it. The new approach is superior to conventional one in that (1) a smaller numerical grid is required due to the localized nature of the interaction picture wave function, since it is not a traveling wave and does not spread appreciably in coordinate space, and thus behaves like a bound state wave function. (2) The interaction picture wave function varies slowly with time and is essentially independent of energy, permitting the use of a large time increment in the numerical integration. Because of these two features in this new approach, we are able to integrate the time dependent wave function once and obtain an accurate *S* matrix over a wide range of energy efficiently.

25112 The potential group approach and hypergeometric differential equations. Wu, J. (Center for Theoretical Physics, Sloane Laboratory, Yale University, New Haven, Connecticut 06511 (US)); Alhassid, Y. *Journal of Mathematical Physics (New York) (USA),* 31(3): 557-562 (Mar 1990).

This paper proposes a generalized realization of the potential groups SO(2,1) and SO(2,2) to describe the confluent hypergeometric and the hypergeometric equations, respectively. It implies that the classes of Schroedinger equations with solvable potentials whose analytical solutions are related to the confluent hypergeometric and the hypergeometric functions can be realized in terms of the above group structure.

70 FUSION ENERGY

25113 (LA-UR–90-370) **Present status of μCF theory.** Leon, M. Los Alamos National Lab., NM (USA). [1989]. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-8911172–1: Symposium on muon catalyzed fusion phenomena, Tokyo (Japan), 2-4 Nov 1989). Order Number DE90007547. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Most of these steps of the catalysis cycle for a dt target are very fast and therefore do not contribute significantly to the cycling time. Energy loss of the free muon is due to electron ejection from target hydrogen molecules, as is most of the deexcitation of the newly-formed muonic atom. This can be either $t\mu$ or $d\mu$; if the latter, the muon can transfer to a t during the deexcitation cascade, since the greater reduced mass means stronger binding for the same n. The μ^- then is in either the $d\mu$ or $t\mu$ ground state; the waiting time in these states dominate the cycling time. Ground-state transfer from $d\mu$ to $t\mu$ is comparatively slow, as is the next step, resonant molecular formation. Once the $dt\mu$ "mesomolecule" is formed (in the loosely-bound J = 1, ν = 1 state), deexcitation to J = 0 via an Auger process and subsequent fusion are very rapid. Because of the large recoil velocity of the α liberated in the fusion reaction d + t → n + α, the μ^- is usually freed to go around the cycle again. We now discuss these steps in detail.

7001 Plasma Research

Refer also to citation(s) 24220, 24838, 24863, 25194, 25195, 25196, 25198, 25199, 25202, 25204

25114 (AD-A–215131/4/XAB) **Nonlinear modulational stability and propagation of an electromagnetic pulse in a two-component, neutral plasma.** Kates, R.E.; Kaup, D.J. Clarkson Univ., Potsdam, NY (USA). 10 Nov 1989. 30p. Available from NTIS, PC A03/MF A01.

Nonlinear effects are studied including possible modulational instability of an intense electromagnetic pulse propagating through a

fully-ionized, unmagnetized plasma. The envelope is shown to evolve over long time scales in general according to a vector form of the well-known cubic nonlinear Schroedinger (NLS) equation. Three distinct nonlinear effects contribute terms cubic in the amplitude and thus can be of comparable magnitude: ponderomotive forces, relativistic corrections, and harmonic generation. Influence of an ambient magnetic field on the nonlinear modulational stability of circularly polarized electromagnetic pulses in a two-component, neutral plasma; the nonlinear modulational stability properties of plasma electromagnetic pulses are extended to include the presence of an ambient magnetic field Bo parallel to the direction of propagation. The positive component may consist of either positrons or singularly charged ions, and specific assumptions or approximations are made concerning the mass ratio of the components. Approximate solutions are derived which describe the evolution of a circularly polarized pulse. The envelope is shown to evolve over long time scales according to the cubic nonlinear Schroedinger (NLS) equation.

25115 (AD-A-215703/0/XAB) **Scaling z-pinch plasmas with atomic number for a given K-shell emission. Memorandum report.** Whitney, K.G.; Apruzese, J.P.; Thornhill, J.W.; Davis, J. Naval Research Lab., Washington, DC (USA). 17 Nov 1989. 34p. (NRL-MR-6579). Available from NTIS, PC A03/MF A01.

A major goal in using z-pinch plasmas as high brightness laboratory sources of x rays is to increase the radiation emission above about 1keV through the use of moderate atomic number (Z = 10 to 36) materials. Two kinds of configuration, single wires and wire arrays or foils, have been investigated in the past. In both cases, it has been observed that optimal x-ray emission decreases on a given machine as the atomic number of the z-pitch material is increased. This paper describes how a previously developed model can be modified and extended to provide predictions of how machine and diode designs must be scaled in order to maintain a given K-shell x-ray emission as the plasma atomic number increases in z-pinch array implosions. Simple scaling arguments are developed to show how specification of a desired total K-shell emission can be used to determine the parameters of an imploding array z-pinch plasma as a function of the atomic number of the pinch. The model we use ignores all hydrodynamic details of the z-pinch implosion and thermalization processes and assumes that all the plasma mass is imploded and thermalized. The pinch is also assumed to be driven by a prescribed linearly rising current. Scaling laws that are derived from these assumptions, in effect, contain phenomenological scaling parameters whose values will need to be more accurately determined by more detailed theoretical calculations and/or by z-pinch experiments on a variety of different machines.

25116 (DOE/ER/52159-1) **Particle reflection and neutral transport in the edge of ITER: Annual progress report, January 15, 1989-January 14, 1990.** Ruzic, D.N. Illinois Univ., Urbana, IL (USA). Aug 1989. 24p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER52159. Order Number DE90008656. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A 2-D Monte-Carlo simulation of the neutral atom densities in the divertor throat, private flux region, and pump duct of ITER were made using the DEGAS code. Plasma conditions were modelled using the B2 plasma transport code. Wall reflection coefficients including the effect of realistic surface roughness were determined by using the Fractal TRIM code. Results were obtained for both helium and deuterium. Pumping ratios and the effects of geometry are discussed. It is found that the detailed geometry and wall model have a significant effect on the helium pumping ratio and neutral atom density profiles. 12 figs.

25117 (DOE/ER/53205-4) **Atomic processes in high temperature plasmas: Annual progress report.** Hahn, Y. Connecticut Univ., Storrs, CT (USA). Mar 1990. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-85ER53205. Order Number DE90008873. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Much theoretical and experimental efforts have been expended in recent years to study those atomic processes which are specially relevant to understanding high temperature laboratory plasmas. For magnetically confined fusion plasmas, the temperature range of interest spans from the hundreds of eV at plasma edges to 10 keV at the center of the plasma, where most of the impurity ions are nearly fully ionized. These highly stripped ions interact strongly with electrons in the plasma, leading to further excitation and ionization of the ions, as well as electron capture. Radiations are emitted during these processes, which easily escape to plasma container walls, thus cooling the plasma. One of the dominant modes of radiation emission has been identified with dielectronic recombination. This paper reviews this work.

25118 (DOE/ER/53278-2) **CIT alpha particle extraction and measurement: Low-Z ablation cloud profile simulation for alpha-particle diagnostics: Annual report, 1 September 1988-19 January 1990.** Gerdin, G.; Vahala, L.; El Cashlan, A.G. Old Dominion Univ., Norfolk, VA (USA). Dept. of Electrical and Computer Engineering. Jan 1990. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER53278. Order Number DE90008701. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In order to determine the expected properties of the ablation cloud of low-Z pellets interacting with a thermonuclear plasma, which in turn is proposed as a charge-neutralization medium for confined alpha particles, a numerical program has been developed. The physical model for this program is based on Parks' low-Z pellet-plasma interaction model for the interior of the cloud adjacent to the pellet's surface out to the sonic surface (roughly, a millimeter in separation) and then propagating outward from this region using the conservation laws of enthalpy, momentum, and mass, along with the assumption of charge-state equilibrium. The effects of local heating by the plasma electrons slowing down in the cloud, and ionization of the ablatant material are treated self-consistently in the model. In collaboration with Dr. Paul Parks of General Atomics Corporation, a joint ODU-GAC research plan for modeling low-Z pellet-plasma interactions has been devised, and considerable progress has been made in its implementation. Recently, using a constraint in the ablatant flow, results from the program were obtained which could be compared with the results from the GAC experiments on TEXT. The predictions of the program are in pretty good agreement with the TEXT data as to the dimensions of the C^{+3} region of the cloud along the magnetic field. Also a small improvement has been made in the low-Z pellet plasma-penetration program, which brings the predictions of the model in closer agreement with the carbon pellet injection experiments on TFTR. 22 refs., 3 figs.

25119 (DOE/ER/53291-150) **A self-consistent theory of radial transport of field-aligned current by microturbulence.** Terry, P.W. (Wisconsin Univ., Madison, WI (USA). Dept. of Physics); Diamond, P.H. Wisconsin Univ., Madison, WI (USA). Plasma Physics Research. Feb 1990. 30p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER53291;FG03-88ER53275. Order Number DE90007920. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The radial transport of field-aligned current due to collisionless microturbulence is examined self-consistently. The self-consistent treatment of mode coupling shown to constrain the transport in such a way that the relaxation of current gradients is regulated solely by electrostatic fluctuations which couple to ion dissipation, even in the presence of temperature gradients and temperature anisotropy. As a consequence, the radial flux of parallel current induced by collisionless microinstabilities is insufficient to account for the dynamo in reversed field pinch plasmas. 26 refs.

25120 (DOE/OR/21400-T417) **Modification of ITER ballooning stability by an energetic alpha population.** Spong, D.A. (Oak Ridge National Lab., TN (USA)); Holmes, J.A.; Christenson, P.J. Oak Ridge National Lab., TN (USA). 8 Sep 1989. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008951. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Alpha particle populations can significantly alter existing MHD instabilities in tokamaks through kinetic effects and coupling to otherwise stable shear Alfven waves. Here we consider resonances with the trapped alpha precessional drift. This is examined in the

high-n ballooning limit using an isotropic alpha slowing down distribution and retaining the full energy and pitch angle dispersion in the alpha drift frequency. We also employ a noncircular tokamak equilibrium model. Applying this to ITER indicates that ballooning instabilities can persist at β's below the ideal MHD threshold. 12 refs., 2 figs.

25121 (DOE/SF/15935–T1) **Exoatmospheric propagation of neutralized ion beams: Final report, September 1985–October 1988.** Drobot, A.T.; Antonsen, T.M. Jr.; Davidson, R.C.; Fritts, M.J.; Grossmann, W.; Horowitz, E.; Mankofsky, A.; Papadopoulos, K.; Petillo, J.; Sudan, R.N. Science Applications International Corp., McLean, VA (USA). Plasma Physics Div. 15 Nov 1988. 27p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC03-85SF15935. (SAIC–88/1956). Order Number DE90008468. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report summarizes the research findings from SAIC's project 1-624-07-624 on "Exoatmospheric Propagation of Neutralized Ion Beams" performed for the Department of Energy San Francisco Operations Office under contract AC03-85SF15935 funded as part of Strategic Defense Research from September 1985 to October 1988. The investigation conducted by SAIC examined four broad issues which were the main tasks under this contract: the charge and current neutralization of an intense ion beam in a weak magnetic field; the macroscopic morphology of cross-field ion beam propagation for high kinetic β situations; the sources of ion beam divergence and expansion; and the role of turbulent and microscopic forces in beam propagation. The physics issues considered and the tools developed to resolve them are of interest in a wide range of applications and represent fundamental concepts that have been the objects of plasma physics research for a very long time. Our main purpose was to understand the conditions, if any, under which an ion beam could propagate across a magnetic field without deflection and to determine the parameters that define the range of propagation. A secondary, but important consideration, was the physics that dictated the beam divergence angle and hence the brightness and utility at range.

25122 (IAEA-TECDOC–536, pp. 49-53) **Method of helium removal from tokamak reactor discharge chamber.** Mirnov, S.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii). International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). In *Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.* Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

The paper describes a new method of helium removal from tokamak plasma by generation between the divertor plates and chamber first wall a screening layer of low-temperature plasma which would ionize and trap neutral atoms. The removal of these atoms out of the chamber could be realized with special pump-limiters. (author). 2 refs, 4 figs.

25123 (JINR-E–4-88-802) **Nuclear-physics diagnostics of ion temperature in hot deuterium-containing plasma.** Kamal, M. (Cairo Univ. (Egypt)); Kukulin, V.I.; Voronchev, V.T. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 6p. Order Number DE90620643. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A nuclear-physics method for finding ion temperature of hot deuterium-containing plasma is proposed. The method is based on ^{6}Li ion injection and subsequent measurements of γ-quantum yield from the reactions $^6Li(d,n)^7Be^* \rightarrow ^7Be+\gamma$ (E_γ=431 keV) and $^6Li(d,p)^7Li^* \rightarrow ^7Li+\gamma$ (E_γ=478 keV). 12 refs.; 2 tabs.

25124 (KFTI–88-3) **Study on the lower hybrid plasma heating in the l=2 torsatrons by the ray trajectories method.** Grekov, D.L.; D'yakov, V.E.; Bachelor, D.B.; Goldfinger, R.S. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 13p. (In Russian). Order Number DE90620581. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Qualitative pattern of lower hybrid heating in stellarators was obtained on the basis of analyzing numerical calculations of ray trajectories of a slow mode of lower hybrid waves. Dependences of lower hybride wave propagation and absorption on plasma temperature and density, frequency, spectrum of longitudinal wave numbers and antenna location were studied. Calculations, where spiral magnetic field of torsatron was assigned by one harmonic, were correlated with calculations, where magnetic field calculated according to Biot-Savart law was used. The correlation showed qualitative agreement of obtained results. 12 refs.; 11 figs.

25125 (KFTI–88-4) **Sound waves in weakly ionized gas.** Bliokh, Yu.P.; Tur, A.V.; Yanovskij, V.V. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 7p. (In Russian). Order Number DE90620704. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Dispersion properties of low-frequency oscillations in weakly ionized gas are considered. It is shown that the presence of charged component leads to sound wave dispersion. The region of modulation instability was determined for nonlinear wave packets. Possibility of existence of isolated waves is shown. 6 refs.

25126 (KFTI–88-5) **Forced scattering of electromagnetic waves on electron beam in periodically inhomogeneous plasma.** Balakirev, V.A. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 20p. (In Russian). Order Number DE90620705. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Parametric processes of excitation of short-wave electromagnetic radiation in periodically inhomogeneous plasma waveguide were investigated. Parametric processes were considered both under conditions of the absence of plasma-beam instability and under the conditions of its development. It is shown that in the first case more complex two-cascade processes (when the beam excites LF+pumping wave on one hand, and scattering on the beam of this wave leads to excitation of HF-radiation - on the other hand) are possible along with parametric Cherenkov mechanism of HF-radiation excitation. Initial stage of these processes was investigated. Excitation of HF-radiation developes most rapidly under conditions of plasma-beam instability. In this case the unstable plasma wave is in parametric resonance with back plasma wave which represents a pumping wave. 17 refs.

25127 (KFTI–88-6) **Dynamics of motion charged particles in a field of two electromgnetic waves.** Balakirev, V.A.; Buts, V.A.; Tolstoluzhskij, A.P.; Turkin, Yu.A. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 17p. (In Russian). Order Number DE90620690. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A study was made on dynamics of charged particle motion in external constant magnetic field and in the field of two electromagnetic waves of arbitrary polarization. The general condition of occurrence of local instability of particle motion was obtained. The condition holds true for all particle resonances with the field of: Cherenkov, cyclotron, cyclotron on normal and abnormal Doppler effect, parametric Cherenkov resonance. It is shown that all presently known conditions of local instability occurrence follow from this condition as particular case. 12 refs.; 1 fig.

25128 (KFTI–88-7) **Influence of plasma inhomogeneity on the charged particle acceleration by modulated electron beam.** Balakirev, V.A.; Onishchenko, I.N.; Ostrovskij, A.O.; Sotnikov, G.V. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 9p. (In Russian). Order Number DE90620656. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Theoretical study was made on the problem of charged particle acceleration by charge density wave of plasma, excited by density modulated tubular electron beam. Results of investigating the effect of plasma inhomogeneity on the process of charged particle acceleration are presented. It is shown that beam modulation decreases the requirements for permissible gradients of plasma inhomogeneity. 8 refs.; 5 figs.

25129 (KFTI–88-9) **Calculation of trajectories of the probing heavy ion beams in the stellarator type devices Uragan-2, Uragan-3, Uragan-2M.** Bykov, V.E. (and others); Krupnik, L.I.; Mel'nikov, A.V. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 20p. (In Russian). Order Number

DE90620644. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Consideration is given to the method of probing by heavy ion beams, calculation of trajectories and determination of configuration and dimensions of studied region. Statements of the problems of optimizing condition of the experiment on plasma probing by heavy particle beams are discussed. Examples of solving optimization problems for conditions of various stellarators are presented. Values of basic parameters of probing beams are determined; different schemes of the experiment, providing for potentialities of modern devices, are suggested. 14 refs.; 13 figs.; 3 tabs.

25130 (KFTI–88-10) **Numerical methods for the problem of the free-boundary plasma equilibrium in a stellarator (torsatron).** Kilovataya, T.G.; Kuznetsov, Yu.K.; Pyatov, V.N.; Yasin, I.V. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 12p. (In Russian). Order Number DE90620580. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Solution of the neutralized equation of plasma equilibrium in a stellarator was obtained with the use of Green function method. Numerical algorithm, using mobile calculation grid and approximation of magnetic field of the real helical winding with assigned accuracy was developed. Calculation results show that increase of plasma pressure in stellarator leads both to change of the structure of internal magnetic surfaces and sufficient deformation of plasma boundary. 12 refs.; 3 figs.

25131 (LRP–340/88) **A non perturbative optical probe for laser induced fluorescence diagnostics in magnetized plasma.** Anderegg, F. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Paris, P.J.; Skiff, F.; Good, T.N.; Tran, M.Q. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jan 1988. 18p. Order Number DE90620582. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

An 'optical carriage' has been developed to improve plasma access for LIF diganostics. Laser light inducing the fluorescence is transported through an optical fiber to the carriage. A telescope fixed on the carriage collects the plasma fluorescence light and sends it through a fiber bundle to an external PMT. The whole carriage is mounted on rails and can be scanned along and acrosss magnetic field. Wave interferograms and slow rotation of a plasma measured via LIF and optical tagging demonstrate the flexibility of the 'optical carriage'. (author) 4 figs., 8 refs.

25132 (LRP–344/88) **The phase contrast method as an imaging diagnostic for plasma density fluctuations.** Weisen, H. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)). Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Mar 1988. 12p. Order Number DE90620584. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Invited paper presented at the 7. Topical conference on high temperature plasma diagnostics, Napa CA, 13-17 Mar 1988.

An imaging diagnostic for the observation of plasma density fluctuations is presented. It is based on the phase contrast method, and is used on the TCA tokamak to investigate fluctuations associated with plasma turbulence and driven waves in radio frequency heating experiment. The diagnostic uses a 23 cm wide CO_2 laser beam transmitted through the plasma, and produces an image of the plasma where the small phase shifts due to refractive perturbations are revealed as corresponding intensity variations. A wide range of fluctuation wavelengths between 0.2 and about 20 cm is accessible to observation, with a sensitivity better than 10^{-5} radiants for a 1 MHz bandwidth. (author) 11 figs., 12 refs.

25133 (LRP–350/88) **An improved barium plasma source for q-machines.** Paris, P.J. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Gorgerat, P.; Simik, A.; Rynn, N.; Roe, S.; Schleipen, M. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jun 1988. 39p. Order Number DE90620596. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We have developed a stable q-machine with well determined parameters for long term times, of constant plasma density and temperature. The plasma characteristics and gun behaviour allow research in fundamental plasma physics, especially with the use of non perturbing powerful optical (LIF) diagnostics in the determination of many of the plasma parameters. (author) 17 figs., 2 tabs., 7 refs.

25134 (LRP–351/88) **Prospects for high power quasi-optical gyrotrons operating in the millimeter wave range.** Tran, T.M. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Tran, M.Q.; Alberti, S.; Hogge, J.P.; Isaak, B.; Muggli, P.; Perrenoud, A. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jul 1988. 33p. Order Number DE90620597. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The prospects for high power (several megawatts) quasi-optical gyrotrons operating in the high frequency region ($\geq$ 150 GHz) are considered. The analysis is mainly concerned with the physics of interaction between the annular electron beam and the electromagnetic field within the quasi-optical resonator, together with the constraints required by long-pulse or cw operations. It is shown that powers of several megawatts at frequencies exceeding 150 GHz are possible if one can maintain single mode operation in the overmoded quasi-optical resonators. A thorough performance study of the magnetron injection gun (MIG) for such high power gyrotrons, is also carried out, using the adiabatic theory as well as the numerical simulations. (author) 6 figs., 2 tabs., 20 refs.

25135 (LRP–353/88) **Measurements of the tokamak safety factor profile by means of driven resonant Alfven waves.** Weisen, H. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Borg, G.; Joye, B.; Knight, A.J.; Lister, J.B. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Aug 1988. 20p. Order Number DE90620598. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We report on the first measurements of the safety factor profile in a tokamak using the dispersion properties of Alfven waves. The waves were launched using the TCA Alfven-wave heating antennae, which allowed the resonant excitation of Alfven waves with defined mode numbers. The associated density oscillation profiles provided the shear Alfven-wave resonance layer positions which, for non-zero poloidal mode numbers, depend on the local value of the safety factor, q. Our results for sawtoothing discharges with different plasma currents show a time-averaged q-profile with a flat central region where q is within a few percent of unity. (author) 6 figs., 18 refs.

25136 (LRP–354/88) **TDA - a three-dimensional axisymmetric code for free-electron-laser (FEL) simulation.** Tran, T.M. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Wurtele, J.S. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Sep 1988. 21p. Order Number DE90620599. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A particle simulation code, TDA, which models the single-pass amplification process in a free-electron-laser (FEL) is developed and tested. The code allows for the treatment of the fully three-dimensional electron dynamics, thus taking into account the transverse betatron motion as well as the longitudinal bunching of the electrons. The paraxial wave equation that governs the growth and the diffraction of the selfconsistent radiation field (assumed to be axisymmetrtic), is discretized in the radial direction by the finite difference method. The benchmark study indicates that the single-pass gain, as well as the optical guiding phenomena can be well described by the code with a reasonable number of simulation particles ($N \approx 1000$) and a radial mesh number not exceeding 64. A detailed discussion of the numerical method is presented. (author) 6 figs., 1 tab., 17 refs.

25137 (LRP–355/88) **Tokamak equilibrium reconstruction using Faraday rotation measurements.** Hofmann, F. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Tonetti, G. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Sep 1988. 26p. Order Number DE90620600. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A new equilibrium reconstruction procedure using magnetic line-integrated electron density and Faraday rotation measurements has been developed. The method has been applied to a number of elongated tokamak equilibria which were computed by using a free-boundary MHD equilibrium code. Typical errors in four global plasmas parameters (β_p, l_i, μ and q_o) are evaluated as functions of the measurement errors and the number of source function parameters. Assuming realistic random perturbations in the measurements, the method allows the reconstruction of source functions with up to six independent parameters. It is shown that, when electron density and Faraday rotation measurements are included, the accuracy in the determination of q_o is increased at least a factor 2, as compared to cases without Faraday rotation data. The effects of adding a diamagnetic probe and of varying the plasma elongation are also investigated. (author) 7 figs., 2 tabs., 14 refs.

25138 (LRP–356/88) **The ion temperature evolution on TCA during Alfven wave heating and in non stationary ohmic conditions.** Chambrier, A. de (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Duval, B.P.; Lister, J.B.; Moret, J.M.; Mompean, F.J. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Oct 1988. 25p. Order Number DE90620601. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

High power Alfven Wave Heating has been applied to the TCA tokamak and results in an electron and ion temperature increase, together with a plasma density rise. The various terms leading to an ion temperature increase are investigated to determine whether any of the applied RF energy is absorbed directly by the ions. This is done by a detailed comparison with non stationary ohmic discharges. We conclude that although a large fraction of the ion temperature increase may be assigned to the density increase, there remains a component that is most simply described by a direct ion heating. (author) 18 figs., 10 refs.

25139 (LRP–357/88) **Ion temperature measurement of a tokamak plasma by collective Thomson scattering of D_2O laser radiation.** Behn, R. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Salito, S.A.; Siegrist, M.R.; Dicken, D.; Hackmann, J. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Oct 1988. 18p. Order Number DE90620602. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A D_2O FIR laser emitting 0.5 J in 1.4 μs at 385 μm and a heterodyne receiver system comprising a Schottky barrier diode mixer with a noise temperature of 8000 K (DSB) were used in a Thomson scattering experiment to measure the ion temperature of a tokamak plasma during a single laser shot. Series of measurements under reproducible plasma conditions have been carried out in H, D and He-plasmas. Their statistical analysis yielded a typical relative error of 25 % for a single shot measurement. (author) 9 figs., 2 tabs., 7 refs.

25140 (LRP–361/88) **Numerical simulations of sawteeth in tokamaks.** Vlad, G. (ENEA, Frascati (Italy). Centro Ricerche Energia); Bondeson, A. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Nov 1988. 32p. Order Number DE90620604. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Numerical simulations of sawteeth in tokamaks have been carried out using reduced magnetohydrodynamics and a simple transport model. The electron temperature is evolved self-consistently including ohmic heating and a strongly anisotropic thermal conductivity. The character of the sawteeth is found sensitive to the values of the transport coefficients. In particular, the perpendicular viscosity ν must be comparable to, or larger than, the perpendicular heat conductivity χ in order for distinct relaxation oscillations to occur. To study the region of high Lundquist number S (up to 10^7), ν and χ have been scaled as 1/S, and S has been varied. The influence of the Lundquist number on the sawtee this strongly affected by modifications of the equilibrium induced by the sawteeth themselves. The collapse time shows a much weaker dependence on S than the expected $S^{1/2}$ scaling, because the deviation of central q away from unity over the sawtooth cycle decreases for increasing S. Furthermore, the resistive instability is turned on quickly because the shear changes from almost zero in the central region to order unity over one resistive layer width. The simulated sawtooth period and collapse time for $S \leq 10^7$ compare favorably with those observed in small and medium size tokamaks. (author) 11 figs., 37 refs.

25141 (LRP–362/88) **Ideal stability of cylindrical plasma in the presence of mass flow.** Bondeson, A. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Iacono, R. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Nov 1988. 48p. Order Number DE90620692. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The ideal stability of cylindrical plasma with mass flows is investigated using the guiding centre plasma (GCP) model of Grad. For rotating plasmas, the kinetic treatment of the parallel motion in GCP gives significantly different results than fluid models, where the pressures are obtained from equations of state. In particular, GCP removes the resonance with slow magnetoacoustic waves and the loss of stability that results in magnetohydrodynamics (MHD) for near-soni flows. Because of the strong kinetic damping of the sound waves in an isothermal plasma, the slow waves have little influence on plasma stability in GCP at low β. In the large aspect ratio, low-β tokamak ordering, Alfvenic flows are needed to change the ideal GCP stability significantly. At lowest order in the inverse aspect ratio, flow can be favorable or unfavorable for stability of local modes depending on the profiles, but external kinks are always destilized by flow if the velocity vanishes at the edge. For high-β, reversed field pinch equilibria, numerical computations show that flow can be stabilizing for local modes, but external modes are destabilized by flow. It is shown that in three dimensions, the MHD equilibrium problem becomes hyperbolic for arbitrarily small flows across the magnetic field, whereas in GCP the equilibrium remains elliptic for sub-Alfvenic flows. (author) 7 figs., 1 tab, 32 refs.

25142 (LRP–363/88) **Deflection type energy analyser for energetic electron beams in a beam-plasma system.** Michel, J.A. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Hogge, J.P. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Nov 1988. 17p. Order Number DE90620605. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

An energy analyser for the study of electron beam distribution functions in unmagnetized plasmas is described. This analyser is designed to avoid large electric fields which are created in multi-grid analysers and to measure directly the beam distribution function without differentiation. As an example of an application we present results on the propagation of an energetic beam (E_b : 2.0 keV) in a plasma (n_o : 1.10^{10} cm^{-3}, T_e : 1.4 eV) (author) 7 figs., 10 refs.

25143 (LRP–374/89) **The use of Alfven waves in NET.** Borg, G.G. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Appert, K.; Knight, A.J.; Lister, J.B.; Vaclavik, J. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Feb 1989. 64p. Contract No 251/86-10/FUCH/NET. Order Number DE90620606. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

A number of features of Alfven wave heating make it potentially attractive for use in large tokamac reactors. Among them are the availability and relatively low cost of the power supplies, the potential ability to act selectively on the current profile, and the probable absence of operational limits in size, fields or density. (author) 26 figs., 10 tabs., 54 refs.

25144 (LRP–376/89) **Control of the vertical instability in tokamaks.** Lazarus, E.A. (General Atomics, San Diego, CA (USA)); Lister, J.B.; Neilson, G.H. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). May 1989. 81p. Order Number DE90620693. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The problem of control of the vertical instability is formulated for a massless filamentary plasma. The massless approximation is justified by an examination of the role of inertia in the control problem. The system is solved using Laplace transform techniques. The linear system is studied to determine the stability boundaries. It is

found that the system can be stabilized up to a critical decay index, which is predominantly a function of the geometry of the passive stabilizing shell. A second, smaller critical index, which is a function of the geometry of the control coils, determines the limit of stability in the absence of derivative gain in the control circuit. The system is also studied numerically in order to incorporate the nonlinear effects of power supply dynamics. The power supply bandwidth requirement is determined by the open-loop growth rate of the instability. The system is studied for a number of control coil options which are available on the DIII-D tokamak. It is found that many of the coils will not provide adequate stabilization and that the use of inboard coils is advantageous in stabilizing the system up to the critical index. Experiments carried out on DIII-D confirm the appropriateness of the model. Using the results of the model study, we have stabilized DIII-D plasmas with decay indices up to 98% of the critical index. Measurement of the plasma vertical position is also discussed. (author) 27 figs., 6 refs.

25145 (LRP–377/89) **A nonlocal analysis of electrostatic waves in hot inhomogeneous bounded plasmas.** Sauter, O. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Vaclavik, J.; Skiff, F. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). May 1989. 47p. Order Number DE90620607. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A second order integro-differential equation that describes electrostatic waves in a slab plasma is solved in its full form. No expansion in the smallness of the ion Larmor radius is made. The plasma may have arbitrary density and temperature profiles and is immersed in a non-uniform field. Only small magnetic field gradients, Maxwellian equilibrium distribution functions, and $k_y = 0$ are assumed. First the integral equation is derived in Fourier space using the linearized Vlasov and Poisson equations, then it is transformed back into real space, which enables us to treat the case of bounded plasmas. The two boundary conditions specified simulate an antenna at one end of the plasma and wave-reflecting walls. Solutions having wavelengths smaller than the ion Larmor radius have been found. Comparison with experiments where ion Bernstein waves are launched in argon and barium plasmas shows very good agreement with the solution of our code SEAL. We also derive and compute a positive-definite formula for the local power absorption. (author) 15 figs., 21 refs.

25146 (LRP–378/89) **Control, pressure perturbations, displacements, and disruptions in highly elongated tokamak plasmas.** Marcus, F.B. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Hofmann, F.; Tonetti, G.; Jardin, S.C.; Noll, P. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jun 1989. 24p. Order Number DE90620608. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The control and evolution of highly elongated tokamak plasmas with large growth rates are simulated with the axisymmetric, resistive MHD code TSC in the geometry of the TCV tokamak. Pressure perturbations such as sawteeth and externally programmed displacements create initial velocity perturbations which may be stabilized by low power, rapid response coils inside the passively stabilizing vacuum vessel, together with slower shaping coils outside the vessel. Vertical disruption induced voltages and forces on the rapid coils and vessel are investigated, and a model is proposed for an additional vertical force due to poloidal currents. (author) 6 figs., 1 tab., 26 refs.

25147 (LRP–380/89) **Mode structure in an optically pumped D_2O far infrared ring laser.** Yuan, D.C. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Soumagne, G.; Siegrist, M.R. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jul 1989. 21p. Order Number DE90620609. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The mode structures in an optically pumped D_2O far infrared ring laser and a corresponding linear resonator have been compared. While single mode operation can be obtained over the whole useful pressure range in the ring structure, this is only possible at pressures greater than 8 Torr in the linear resonator case. A numerical model predicts quite well the pulse shape, pressure dependence and influence of the resonator quality in the ring cavity. (author) 12 figs., 8 refs.

25148 (ORNL/FEDC–89/1) **International Thermonuclear Engineering Reactor: Bimodal device and design sensitivities to energy confinement H-factors.** Galambos, J.D.; Peng, Y-K.M. Oak Ridge National Lab., TN (USA). Fusion Engineering Design Center. Jan 1990. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008085. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A major concern of present-day tokamak design is the uncertainty in the plasma energy confinement scaling. We present sensitivities of designs similar to the International Thermonuclear Engineering Reactor (ITER) to changes in the energy confinement H-factor (H) for cases designed for ignition (the ITER physics phase), long-pulse, current-driven operation (the ITER technology phase), and achievement of both phases in a single device (bimodal). For cases that require ignition, the cost increases sharply for H-factors below 2. For technology-phase cases, the costs are much less sensitive to H-factor variations. For bimodal cases with $H \geq 1.8$, the ignition criteria dominate if the energy multiplication factor Q need only be 5 in the technology phase; if $Q \geq 10$ is required, the current drive criteria dominate. The bimodal cases are at most ≈10% more expensive than the more costly of the physics-only and technology-only cases. Thus, the present ITER scheme of replacing the blanket and shield of the device between phases may not be the most cost-effective way to accomplish the desired performance goals. Investigation of device sensitivity to the H-factor indicates that, as the H-factor decreases from 1.8 to 1.2 for a given device, the achievable Q drops from ≈10 to ≈5 and the divertor heat load increases by 50%. 8 refs., 4 figs., 2 tabs.

25149 (PB–90-135724/XAB) **Analysis of electric potential measurements in ISX-B.** Indireshkumar, K.; Stacey, W.M. Georgia Inst. of Tech., Atlanta, GA (USA). Fusion Research Center. Jun 1989. 18p. (GTFR–90). Available from NTIS, PC A03/MF A01.

Electric potential measurements made on ISX-B tokamak during neutral beam injection have been calculated from fluid theory momentum balance, including beam momentum input and radial transport. Measured potential profiles and central rotation velocities during co- and counter-injection have been compared with theoretical predictions. Within the uncertainties of measured potential and central rotation velocities, reasonable agreement is seen between theory and experiment.

25150 (PPPL–2676) **Image reconstruction methods for the PBX-M pinhole camera.** Holland, A.; Powell, E.T.; Fonck, R.J. Princeton Univ., NJ (USA). Plasma Physics Lab. Mar 1990. 43p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE90008152. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper describes two methods which have been used to reconstruct the soft x-ray emission profile of the PBX-M tokamak from the projected images recorded by the PBX-M pinhole camera. Both methods must accurately represent the shape of the reconstructed profile while also providing a degree of immunity to noise in the data. The first method is a simple least squares fit to the data. This has the advantage of being fast and small, and thus easily implemented on the PDP-11 computer used to control the video digitizer for the pinhole camera. The second method involves the application of a maximum entropy algorithm to an overdetermined system. This has the advantage of allowing the use of a default profile. This profile contains additional knowledge about the plasma shape which can be obtained from equilibrium fits to the external magnetic measurements. Additionally the reconstruction is guaranteed positive, and the fit to the data can be relaxed by specifying both the amount and distribution of noise in the image. The algorithm described has the advantage of being considerably faster, for an overdetermined system, than the usual Lagrange multiplier approach to finding the maximum entropy solution. 13 refs., 24 figs.

25151 (PPPL–2679) **In-situ calibration of TFTR [Tokamak Fusion Test Reactor] neutron detectors.** Hendel, H.W.; Palladino, R.W.; Barnes, C.W.; Diesso, M.; Felt, J.S.; Jassby, D.L.; Johnson, L.C.; Ku, L.P.; Liu, Q.P.; Motley, R.W. Princeton Univ., NJ (USA). Plasma Physics Lab. Mar 1990. 56p. Sponsored by

U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE90007943. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

We report results of the TFTR fission detector calibration performed in December 1988. A NBS-traceable, remotely controlled ^{252}Cf neutron source was moved toroidally through the TFTR vacuum vessel. Detection efficiencies for two ^{235}U detectors were measured for 930 locations of the neutron point source in toroidal scans at 16 different major radii and vertical heights. These scans effectively simulated the volume-distributed plasma neutron source, and the volume-integrated detection efficiency was found to be insensitive to plasma position. The Campbell mode is useful due to its large overlap with the count rate mode and large dynamic range. The resulting absolute plasma neutron source calibration has an uncertainty of ± 13%. 21 refs., 23 figs., 4 tabs.

25152 Dispersion and gain in generic slow-wave structures. Walsh, J.E. (Dartmouth Coll., Hanover, NH (USA)); Fisch, E.F.; Jackson, J.A.; Xu, Y.; Marshall, E.M. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Two devices: the dielectric-lined waveguide or Cerenkov maser and the metal grating based planar protron, have been operational for several years. Recently a segmented grating resonator, the planar-grating klystron, has also been introduced. The grating in the protrons and the dielectric in the Cerenkov device serve as slow-wave structures which guide electromagnetic radiation and couple it to an electron beam. The frequency and output power of the radiation produced depend upon the characteristics of both the beam and the slow-wave structure. A generic theory which is capable of predicting the tuning, gain, saturation, relative efficiency and sensitivity to electron beam quality has been developed. An introduction to the theory and a summary of some recent applications are discussed.

25153 Emission spectroscopic studies of copper contamination in a free-burning argon arc. Roberts, M. (State Univ. of New York, Buffalo, NY (USA). Dept. of Electrical and Computer Engineering); Etemadi, K. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors report the vapor density distribution of copper contaminants evaporated from the water-cooled anode of an atmospheric pressure free-burning arc (200 A and 1 cm gap spacing) measured by emission spectroscopy. An automated emission spectroscopic set-up has been developed in order to minimize the time for data acquisition and data evaluation. The vapor density distribution was then measured in a two-step process. In the first step the temperature distribution in the plasma was measured by using the absolute line intensity method at the argon spectral line 4300 A. In the second step the vapor density distribution of copper as determined by measuring the absolute intensity distribution of the copper spectral line 5218A. The copper vapor penetrates the cathode region and the arc column. The measurements show that the copper vapor is mainly concentrated in the fringes of the arc and in the center of the arc column with a radius of 1 mm. The vapor density distribution in the arc column is more concentric towards the cathode tip.

25154 Down stream oxidation of silicon using an ECR microwave plasma disk reactor. Salbert, G.T. (Michigan State Univ., East Lansing, MI (USA)); Reinhard, D.K.; Asmussen, J. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

A microwave plasma disk reactor (MPDR) is being used to develop a low temperature method for growing high quality oxides on silicon wafers. In this application, the PMDR is used an an electrodeless, low maintenance, high density source of energetic oxygen ions and free radicals which are applied in the anodic growth of oxides on silicon. It is excited in a tuned, single resonant mode for efficient coupling to the plasma. The apparatus has previously been used to demonstrate the growth of high quality oxides over small areas in non-ECR microwave discharges. In this work, oxidation of a 7.6 cm diameter silicon wafer is accomplished using a 2.45 GHz multicusp electron cyclotron resonant (ECR) MPDR. The potential of scaling to a 6 to 8 inch wafer ECR processing system is discussed.

25155 Fourier transform mass spectrometry in an ECR plasma. Shohet, J.L. (Engineering Research Center for Plasma-Aided Manufacturing, Univ. of Wisconsin-Madison, Madison, WI (USA)); Friedmann, J.; Wendt, A.; Brenna, J.T. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

ECR plasmas can be operated successfully at much lower pressures than convention rf or d.c. discharges. There is a need for in-situ mass measurements of active species in an ECR plasma reactor. In this paper, together with the presence of a relatively strong d.c. magnetic field, consideration is given to the use of Fourier transform mass spectrometry techniques to provide such a measurement. FTMS can produce spectra with a very high degree of resolution for ions which have high masses, and for both positive and negative ions. An electron cyclotron resonance plasma was produced in a vacuum chamber placed inside a d.c. magnetic mirror field by microwaves whose power level could be adjusted up to 2 kW cw. The electron cyclotron resonance was adjusted to be approximately 25% on the distance from the "throat" of the mirror to the mid-plane of the vacuum chamber. The mirror ratio was 2:1. The operating gas was Argon and the pressure was set to 2×10^{-4} torr. A test plasma could then be produced. FTMS tok place in a cubical cell placed in the center of the magnetic mirror region where the magnetic field was most uniform. Trapping of the ions is accomplished by applying a d.c. potential to the plates of the FTMS cell which are perpendicular to the axis of the magnetic field.

25156 Cars diagnostics for combustion and plasma processes. Eckbreth, A.C. (United Technologies Research Center, East Hartford, CT (USA)); Stufflebeam, J.H. pp. 322 of Process diagnostics: Materials, combustion, fusion. Hays, A.K.; Eckbreth, A.C.; Campbell, G.A. Materials Research Society, Pittsburgh, PA (1988). (CONF-8804121–: MRS symposia on process diagnostics: materials, combustion, and fusion, Reno, NV (USA), 5-7 Apr 1988).

Coherent anti-Stokes Raman spectroscopy (CARS) is an analysis approach for nonintrusive temperature and species measurements in hostile environments. Widely utilized in combustion, it may be able to significantly impact materials processing research. CARS is described. Its applications to combustion and plasma process environments are reviewed and contrasted.

25157 Measurements of classical deceleration of beam ions in the DIII-D tokamak. Heidbrink, W.W. (Department of Physics, University of California, Irvine, California 92717 (US)). *Physics of Fluids B (USA)*, 2(1): 4-5 (Jan 1990).

Studies of the slowing down of short pulses of deuterium beam ions in the DIII-D tokamak [Nucl. Fusion **28**, 1897 (1988)] are extended to the regime where ion drag dominates electron drag. The deceleration of the beam ions is consistent with Sivukhin's classical theory [*Reviews of Plasma Physics* (Consultants Bureau, New York, 1966), Vol. 4, p. 93] to witnin 25%.

25158 Turbulent relaxation in magnetohydrodynamic plasma. Tetreault, D.J. (Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (US)). *Physics of Fluids B (USA)*, 2(1): 53-66 (Jan 1990).

Magnetohydrodynamic (MHD) clump instability is considered as a turbulent relaxation mechanism for current carrying plasma. Predictions of the instability are compared with results from laboratory fusion experiments as well as computer simulations. For the tokamak, the predictions include safety factor [$q(a) \leq 3$] and Lundquist number [$S \geq 10^4$] thresholds, a magnetic helicity conserving radial electric field profile, and a voltage spike time of $0.1\tau_R S^{-1/3}$, where

τ_R is the resistive time. It is argued that the voltage spike that signals a tokamak disruption is due to the global conservation of magnetic helicity during the instability. In the reversed field pinch (RFP), clump steady states corresponding to B_{0z} field reversed Taylor states at pinch parameters $\theta \geq 1.2$, for $S \geq 10^2$, and magnetic fluctuation levels δB scaling as $S^{-3/8}$ and θ^3 are predicted. Reasonable agreement is obtained. The MHD clump instability appears to provide a unified picture of tokamak disruptions, where it occurs intermittently in its growth phase, and RFP "quiescent" states, where it is continuously present in its steady state turbulence phase.

25159 A tearing mode energy principle for an axisymmetric finite beta plasma. Chu, M.S. (General Atomics, San Diego, California 92138-5608 (US)); Chance, M.S.; Greene, J.M.; Jensen, T.H. *Physics of Fluids B (USA),* 2(1): 97-105 (Jan 1990).

A self-adjoint, gauge invariant stability functional δW_{TG} for determination of a sufficient condition of tearing mode stability is obtained for a plasma with arbitrary current and pressure profiles. The plasma is stable if there is no free energy available to support energy flux into the singular layer. The pressure gradient near the singular layer is found to be stabilizing. The tearing mode energy drive is extracted by casting the problem into its nonlinear context, demanding that both large and small solutions be continuous across the singular layer.

25160 Influence of sheared poloidal rotation on edge turbulence. Biglari, H. (Department of Physics, University of California at San Diego, La Jolla, California 92093 (USA)—General Atomics, San Diego, California 92138 (US)); Diamond, P.H.; Terry, P.W. *Physics of Fluids B (USA),* 2(1): 1-4 (Jan 1990).

The impact of radially sheared poloidal flows on ambient edge turbulence in tokamaks is investigated analytically. In the regime where poloidal shearing exceeds turbulent radial scattering, a hybrid time scale weighted toward the former is found to govern the decorrelation process. The coupling between radial and poloidal decorrelation results in a suppression of the turbulence below its ambient value. The turbulence quench mechanism is found to be insensitive to the sign of either the radial electric field or its shear.

25161 Inversion of the ballooning transformation. Hazeltine, R.D. (Institute for Fusion Studies and Department of Physics, The University of Texas at Austin, Austin, Texas 78712 (USA)); Newcomb, W.A. *Physics of Fluids B (USA),* 2(1): 7-10 (Jan 1990). DOE Contract FG05-80ET53088.

The ballooning formalism can be viewed, not just as an eikonal representation, but as an integral transform, analogous to the Fourier or Laplace transforms, with a uniquely defined inverse. Here, the inversion theorem is proved, and an error in the previous literature is corrected.

25162 Ballooning transformation. Newcomb, W.A. (Lawrence Livermore National Laboratory, University of California, Livermore, California 94550 and Department of Applied Science, University of California, Davis, California 95616 (US)). *Physics of Fluids B (USA),* 2(1): 86-96 (Jan 1990). DOE Contract W-7405-ENG-48.

A study is made of the stability against localized perturbations of an idealized toroidal magnetostatic equilibrium. The principal new result is a corrected version of the so-called "ballooning transformation" whereby periodic perturbations of the toroidal system are mapped onto aperiodic perturbations of the corresponding unbounded system.

25163 Spectra of the Si I isoelectronic sequence from Cu XVI to Mo XXIX. Sugar, J. (National Institute of Standards and Technology, Gaithersburg, Maryland 20899 (USA)); Kaufman, V. *Journal of the Optical Society of America, Part B: Optical Physics (USA),* 7(2): 152-158 (Feb 1990).

Si-like spectra of Cu to Mo have been observed in tokamak-generated plasmas, and Cu to As in laser-produced plasmas. Wavelengths in the range of 86 to 300 A were recorded photographically with a 2.2-m grazing-incidence spectrograph on the tokamak, and a 10.7-m grazing-incidence spectrograph for the laser plasmas. Wavelength accuracy is estimated to be ±0.005 A. The transition arrays $3s23p^2$–$3s3p3$ and $3s^23p2$–$3s^23p3d$ were identified. Classifications were established by comparison with Hartree–Fock calculations of wavelengths and relative intensities along isoelectronic sequences. Spectra of Rb and Sr were not observed, but interpolated values of wavelengths for these ions are derived from the rest of the data. Ground configuration intervals known from magnetic dipole transitions are compared with Dirac–Fock calculations to predict unknown values and to correct misidentifications.

25164 Experimental studies of linear high-beta heliac plasma configurations. Greenfield, C.M. (University of Washington, Seattle, Washington 98195 (US)); Koepke, M.E.; Ribe, F.L. *Physics of Fluids B (USA),* 2(1): 133-142 (Jan 1990).

The formation and quasi-equilibrium of a high-beta heliac plasma are investigated in the High-Beta Q Machine [Phys. Fluids **30**, 2885 (1987)], a linear high-beta ≳1 stellarator with an internal current carrying conductor (hardcore). The hardcore current rise time is varied from 9 μsec to smaller values comparable with that of the main compression field (450 nsec). Flux contours and plasma pressure calculated from internal magnetic-probe measurements are used to distinguish between nearly axisymmetric plasma confined near the hardcore and the heliac plasma confined near the magnetic axis. For the shorter hardcore rise times, the axisymmetric plasma pressure becomes small compared to that of the heliac. Further analysis of the data allows calculation of the currents flowing in the plasma, the rotational transform, and the magnetic well depth. Appreciable axial current is observed, consistent with induction by the changing magnetic fields during the heliac formation. The observed relationship between the axial current and rotational transform is confirmed by computer modeling using the HASE magnetohydrodynamic equilibrium code [Nucl. Fusion **23**, 1061 (1983)].

25165 Energetic electron measurements in the edge of a reversed-field pinch. Ingraham, J.C. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (US)); Ellis, R.F.; Downing, J.N.; Munson, C.P.; Weber, P.G.; Wurden, G.A. *Physics of Fluids B (USA),* 2(1): 143-159 (Jan 1990).

The edge plasma of the ZT-40M [Fusion Technol. **8**, 1571 (1985)] reversed-field pinch has been studied using a combination of three different plasma probes: a double-swept Langmuir probe, an electrostatic energy analyzer, and a calorimeter–Langmuir probe. The edge plasma has been measured both with and without a movable graphite tile limiter present nearby in the plasma. Without a limiter a fast nonthermal tail of electrons ($T \gtrsim 350$ eV) is detected in the edge plasma with nearly unidirectional flow along **B** and having a density between 2% and 10% of the cold edge plasma ($T \gtrsim 20$ eV). The toroidal sense of this fast electron flow is against the force of the applied electric field. A large power flux along **B** is measured flowing in the same direction as the fast electrons and is apparently carried by the fast electrons. With the limiter present the fast electrons are still detected in the plasma, but are strongly attenuated in the shadow of the limiter. The measured scrape-off lengths for both the fast electrons and the cold plasma indicate cross-field transport at the rate of, or less than, Bohm diffusion. Estimates indicate that the fast electrons could carry the reversed-field pinch current density at the edge and, from the measured transverse diffusion rates, could also account for the electron energy loss channel in ZT-40 M. The long mean-free-path kinetic nature of these fast electrons suggests that a kinetic process, rather than a magnetohydrodynamic process that is based upon a local Ohm's law formulation, is responsible for their generation.

25166 A moving finite element model of the high density z-pinch. Glasser, A.H. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (US)). *Journal of Computational Physics (USA),* 85(1): 159-209 (Nov 1989).

This paper presents the results of computations of the behavior of the fiber-initiated high density Z-pinch (HDZP). It purpose is twofold. One is to study the behavior of the physical system itself as an interesting controlled fusion experiment. The main result of this study is a demonstration of the relaxation of the full inertial behavior of the pinch to simplified self-similar behavior in which the forces on the system are in near balance. The moving free boundary and violent initial behavior of this configuration require carful treatment. This leads to the other purpose of the work, to use this realistic physical system as a test-bed for a general-purpose 1-dimensional code based on moving finite elements. A key step in

accomplishing this goal has been the recognition that numerical stability of the discretized equations has required the use of nonconservative quantities as the fundamental dependent variables to be discretized. The main result of this work is a code which is capable of treating a very general class of nonlinear, time-dependent fluid equations. © 1989 Academic Press, Inc.

25167 Comment on "Energy and nonlinearity considerations for the enhanced plasma wave model of Raman scattering" [Phys. Fluids B 1, 1073 (1989)]. Drake, R.P. (Lawrence Livermore National Laboratory, Livermore, California 94550 (US)). *Physics of Fluids B (USA),* 2(1): 225-226 (Jan 1990). DOE Contract W-7405-ENG-48.

The interpretation of some recent experiments [Phys. Rev. Lett. **60**, 1018 (1988); Phys. Fluids **30**, 1795 (1988)] by Simon and Short [Phys. Fluids B **1**, 1073 (1989), referred to as SS4] is discussed. The predicted angular distribution is almost narrow enough to correspond to the data discussed in SS4, but not to correspond to data from previous experiments having similar plasma-wave damping but much smaller density-gradient scale length. Examination of the time dependence of the Raman spectrum in all the data, rather than only the single case discussed in SS4, shows that the hydrodynamic behavior, rather than the vanishing of quarter critical, determines the time of maximum emission. Finally, it is notable that the analysis of the power flow in SS4 requires that most of the laser energy be converted into intense electron beams with narrow velocity distributions having intensities of 20× the average laser power. Though not impossible, this seems unlikely.

25168 Resistive tearing instability with equilibrium shear flow. Chen, X.L. (Institute for Fusion Studies, The University of Texas at Austin, Austin, Texas 78712 (US)); Morrison, P.J. *Physics of Fluids B (USA),* 2(3): 495-507 (Mar 1990).

The effect of equilibrium velocity shear on the resistive tearing instability has been systematically studied, using the boundary layer approach. Both the "constant-ψ" tearing mode, which has a growth rate that scales as $S^{-3/5}$, and the "nonconstant-ψ" tearing mode [$\Delta'(\alpha S)^{-1/3} \gg 1$], which has a growth rate that scales as $S^{-1/3}$, are analyzed in the presence of flow. Here S is the usual ratio of the resistive diffusion and Alfven times. It is found that the shear flow has a significant influence on both the external ideal region and the internal resistive region. In the external ideal region, the shear flow can dramatically change the value of the matching quantity Δ'. In the internal resistive region, the tearing mode is sensitive to the flow shear at the magnetic null plane: $G'(0)$. When $G'(0)$ is comparable to the magnetic field shear, $F'(0)$, the scalings of the constant-ψ tearing mode are changed and the $\Delta' > 0$ instability criterion is removed, provided $G'(0)G''(0) - F'(0)F''(0) \neq 0$. The scalings of the nonconstant-ψ tearing mode remain unchanged. When the flow shear is larger than the magnetic field shear at the magnetic null plane, both tearing modes are stabilized. Finally, the transition to ideal instability is discussed.

25169 Alfven-ion-cyclotron instability and absence of sawteeth in tokamaks. Litwin, C. (Department of Nuclear Engineering and Engineering Physics, University of Wisconsin, Madison, Wisconsin 53706 (US)). *Physics of Fluids B (USA),* 2(3): 463-466 (Mar 1990).

Linear stability of the anisotropic energetic ion population, observed in recent experiments at the Joint European Torus [Phys. Rev. Lett. **60**, 2148 (1988)], to Alfven-ion cyclotron wave excitations is analyzed and the saturation mechanism is discussed. In the absence of external heating the anisotropic distribution lifetime is found comparable to the observed delay time in the monster sawtooth crash after the turn-off of the heating. It is suggested that the ponderomotive force of unstable waves is responsible for this delay. Saturated wave fields are found sufficiently large to stabilize the internal kink mode.

25170 The effect of compressibility on magnetohydrodynamic instabilities in toroidal tokamak geometry. Charlton, L.A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-8071 (US)); Carreras, B.A. *Physics of Fluids B (USA),* 2(3): 539-546 (Mar 1990). DOE Contract AC05-84OR21400.

The effect of compressibility on the stability of ideal internal kink modes, ballooning modes, and infernal modes is studied. Most characteristics of these modes and their thresholds are not affected by compressibility. However, in general, the linear growth rates obtained from calculations that include compressibility are larger than those from calculations that do not. In the calculations with compressibility, the sound wave contribution to δW, $\Gamma|\nabla \cdot \mathbf{V}|^2$, is negligible. The increase in the linear growth rate with compressibility is caused mainly by the change in the parallel component of the displacement vector.

25171 Toroidal field generation and magnetic field relaxation in a conical-theta-pinch-generated configuration. Wira, K. (Department of Nuclear Engineering, A.E.R. Lab. FL-10, University of Washington, Seattle, Washington 98195 (US)); Pietrzyk, Z.A. *Physics of Fluids B (USA),* 2(3): 561-573 (Mar 1990).

The configurations generated by conical theta pinches (CθP's) of angles 10° and 18° were studied experimentally. The hydrogen plasma density and temperature were approximately $1–3\times10^{15}$ cm^{-3} and 5 eV, respectively. The magnetic field structure was measured by four three-dimensional magnetic probes. The magnetic helicity and energy of the configuration were calculated directly from the measured magnetic field through algorithms that were independent of the chosen coordinate and configuration axis. The magnetic fluxes were calculated after the axis was located. Single-fluid model equations predict that the toroidal field can be generated by effects that are normally neglected in the simple Ohm's law, of which the Hall effect is the most important. The average toroidal field generation was measured to vary quadratically with the cone angle of the CθP, and this field could be accounted for by the Hall effect alone. The time histories of the magnetic helicity and energy decay and poloidal to toroidal flux conversion indicated that the relaxation of the configuration had occurred in agreement with the Taylor hypothesis. The relaxation time history indicated that the relaxation behaved like a turbulent relaxation process. Therefore a spheromaklike configuration could either be generated directly by the CθP (if the generated toroidal and poloidal field had an appropriate distribution) or through relaxation (if only small amount of toroidal field was generated).

25172 Transition from neoclassical to turbulent electron diffusion. Kim, D.E. (Korea Advanced Institute of Science and Technology, Seoul, Korea (USSR)); Choi, D.; Horton, W.; Yushmanov, P.N.; Parail, V.V. *Physics of Fluids B (USA),* 2(3): 547-553 (Mar 1990).

Electron diffusion in tokamak geometry is calculated including both the Coulomb collisional pitch angle scattering and the electromagnetic drift wave fluctuation spectrum. In the weak fluctuation limit the neoclassical banana-plateau diffusion coefficient is recovered. At higher fluctuation levels typical of the mixing length amplitude the anomalous transport formulas of drift wave turbulence are recovered using test particle simulations.

25173 Numerical drift orbit calculations for force-free spheromak configurations. Sahlin, P.A. (School of Applied and Engineering Physics, Cornell University, Ithaca, New York 14853 (USA)); Pierce, W.; Biglari, H.; Fleischmann, H.H.; Jardin, S.C. *Physics of Fluids B (USA),* 2(3): 554-560 (Mar 1990). DOE Contract AC02-76ET53017;AC02-76CH03073.

A numerical analysis was performed of guiding-center (gc) orbits in a variety of spheromak-type force-free, numerically determined equilibria including the normal spherical configurations as well as configurations that are more prolate and oblate, and others having hollow or peaked current profiles. The calculated drift orbits differ significantly from the well-known drift orbits in tokamaks. In particular, the results indicate (i) the existence of particles trapped in separate hemispheres, (ii) the orbit widths d are about proportional to the Larmor radius ρ of the particle (calculated for the field maximum) up to $\rho \approx 0.01–0.02$ of the major separatrix dimension, (iii) many orbits, in particular on the outer flux lines, have their maximum normalized width d_{max}/ρ_L(ρ_L= local Larmor radius) away from the midplane of the configuration, and (iv) these maximum normalized widths are about 2–4 over most of the volume for all configurations except for prolate ones with a peaked current profile; in the latter configurations, orbits on outer field surfaces show $d_{max} \leq \rho_L$.

25174 Particle acceleration by a wave in a strong magnetic field: Regular and stochastic motion. Karimabadi, H. (Institute of Geophysics and Planetary Physics, University of California, Los Angeles, California 90024 (US)); Akimoto, K.; Omidi, N.; Menyuk, C.R. *Physics of Fluids B (USA)*, 2(3): 606-628 (Mar 1990).

A general theory for the acceleration of a charged particle by a coherent wave of arbitrary polarization, propagation angle, and phase velocity in the presence of a uniform and strong magnetic field is presented. It is shown that the Hamiltonian surfaces are topologically open for waves with parallel phase velocity, $\omega/k_{\|}$, equal to or larger than the speed of light. The trapping width is found to be a strong function of the index of refraction (N), and for N=1 the trapping width increases as a function of the harmonic number. Particular emphasis is put on waves with $N_{\|} \equiv ck_{\|}/\omega$=1, and it is demonstrated that the physics of such waves is the relativistic counterpart of the nonrelativistic particle acceleration by a perpendicularly propagating wave. It is found that even at small wave amplitudes particles can be accelerated coherently to very large energies (relativistic factor γ>8) in the presence of such waves. The autoresonance acceleration mechanism is shown to be a special case of particle acceleration by waves with $N_{\|}$ =1. A detailed analysis of the dispersion properties of these waves in a cold plasma is given. Finally, a novel mechanism for coherently accelerating particles to unlimited energies is presented. This new mechanism requires waves with $N_{\|} \lesssim$1 and wave amplitudes large enough so that the zeroth-order particle motion is the trapping due to the wave ("weak" magnetic field limit) rather than the Larmor gyration which was the case for the autoresonance mechanism. This new mechanism is somewhat similar to the surfatron mechanism but can operate even if the wave amplitude is smaller than the magnetic field as a result of the oblique propagation angle of the wave.

25175 Structure of the plasma sheath in collisional to weakly collisional plasmas. Zawaideh, E. (Hughes Aircraft Company, 6155 El Camino Real, Carlsbad, California 92008 (USA)); Kim, N.S.; Najmabadi, F. *Physics of Fluids B (USA)*, 2(3): 647-654 (Mar 1990).

Recently, a set of two fluid equations has been derived that describes the transport of plasmas with anisotropic pressure along the lines of force and is valid for collisional to weakly collisional regimes [Phys. Fluids **29**, 463 (1986); **31**, 3280 (1988)]. These transport equations coupled with Poisson's equation are used to study the structure of the nonquasineutral transition region between the plasma and the material wall. This transition region is defined as the electric sheath region. The Bohm sheath criteria has been derived by various authors by examining behavior of the solution to the plasma-sheath equation. These investigations have shown that only for a supersonic flow would an increasing electric potential (in magnitude) exist in the sheath region to accelerate the ions further toward the wall. For subsonic flows, the behavior of the electric potential is purely oscillatory, which is not physical (electrons would trap in these potential wells and wipe them out). This work shows that when a more accurate set of equations is used, the solution is purely oscillatory when the flow speed is below the ion "thermal speed." For flow velocities in the range between the thermal and sound speed, there exist solutions where the electric field is positive definite and oscillatory but the potential is monotonic. Therefore, solutions to the sheath problem exist for subsonic flow and Bohm's sheath criteria can be violated.

25176 Analysis of the expected resolution of the electron-cyclotron emission crossed-sightline magnetic field diagnostic. Hanson, G.R. (Nuclear Engineering Program, Georgia Institute of Technology, Atlanta, Georgia 30332 (US)); Thomas, C.E. Jr. *Review of Scientific Instruments (USA)*, 61(2): 671-685 (Feb 1990).

The local value of the magnetic field $B(r)$ inside the plasma in magnetic fusion experiments is a quantity of considerable interest. Given information about plasma density and temperature it can be used to calculate the poloidal magnetic field, or given a zero current device (or the current profile) the local value of beta. The time history $B(r,t)$ can be used to infer the level of magnetic fluctuations in the plasma. The poloidal magnetic field and the level of magnetic fluctuations are particularly interesting quantities, since they are difficult to measure, and are both important for understanding particle and energy transport in magnetic fusion experiments. In fact, to date, no measurement of the local value of the total magnetic field or its time variation has been made in a high temperature plasma. Previous measurements have been confined to relatively cold plasmas where probes could be used, or have inadequate resolution to distinguish the value of the field with plasma present from its vacuum value. It has been recently suggested that crossed-sightline correlation of electron-cyclotron emission might be used to infer $B(r_x,t)$ at the crossing point r_x in the plasma of the two sightlines. The equations and techniques necessary to simulate this proposed diagnostic are developed below, and the results of a numerical simulation of the diagnostic resolution for both TEXT and CIT are presented.

25177 X-ray imaging arrays for impurity transport studies on the Texas Experimental Tokamak. Wenzel, K.W. (MIT Plasma Fusion Center, Cambridge, Massachusetts 02139 (US)); Petrasso, R.D. *Review of Scientific Instruments (USA)*, 61(2): 693-700 (Feb 1990). DOE Contract AC02-78ET51013.

Three multichannel soft x-ray imaging arrays are used for impurity transport studies on the Texas Experimental Tokamak. The entire system has a total of 92 broadband x-ray detectors that view the plasma at the same toroidal location from three different poloidal angles: Array A is a 40-channel vertically viewing set of silicon surface barrier diodes (SBDs); array B is a 40-channel horizontally viewing set of SBDs; and array C is a 12-channel set of *p*-intrinsic-*n* (*p-i-n*) detectors viewing the plasma from 45° above the horizontal plane. Array B is absolutely calibrated; array A is relatively calibrated *in situ*; and array C is cross-calibrated relative to array B. In this article we describe the primary components of the system: (1) the specific x-ray diodes used for the arrays and their spectral sensitivities; (2) the corresponding electronics necessary for data acquisition; and (3) the vacuum system for the arrays. Furthermore, we describe a novel krypton edge absorption filter which discriminates between the resonance line radiation of He-like and H-like aluminum injected into TEXT plasmas.

25178 Observation of a two-component electron population in a hollow cathode discharge. Hershcovitch, A.I. (AGS Department, Brookhaven National Laboratory, Upton, New York 11973 (US)); Kovarik, V.J.; Prelec, K. *Journal of Applied Physics (USA)*, 67(2): 671-674 (15 Jan 1990).

A retarding potential technique has been employed to select electrons for extraction from a hollow cathode discharge. In "normal" operating pressures, the electron distribution function is Gaussian like with a superthermal tail. At low operating pressures, the electron distribution function has an additional distinct component of electrons with a very low thermal spread of 0.13 eV and an energy corresponding to the cathode potential.

25179 Magnetosonic wave generation by super-Alfvenic ion ring propagation in plasma. Schamiloglu, E. (Laboratory of Plasma Studies, Cornell University, Ithaca, New York 14853 (US)); Greenly, J.B.; Hammer, D.A. *Applied Physics Letters (USA)*, 55(26): 2727-2729 (25 Dec 1989).

A weakly diamagnetic rotating proton beam propagating at about four times the Alfven speed along a magnetized hydrogen plasma column generated magnetosonic waves when the beam rise time was less than about three radial Alfven transit times. The waves were collisionally damped and the damping increased as the induced cross-field plasma current became stronger. Our beam and plasma conditions suggest that the damping is due to an enhanced collision frequency resulting from a modified two-stream instability.

25180 Quiescent window for global plasma modes. Coppi, B. (Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (USA)); Detragiache, P.; Migliuolo, S.; Pegoraro, F.; Porcelli, F. *Physical Review Letters (USA)*, 63(25): 2733-2736 (18 Dec 1989).

A consistent theoretical description of the global plasma modes that are excited or suppressed by the presence of a high-energy particle population is given. The present analysis underlines the importance of a finite-energetic particle response in the limit of vanishing perturbation frequency in order to stabilize resistive modes responsible for the so-called "sawtooth" oscillations of the central region of the plasma column.

25181 **Plasma jets from laser-irradiated planar targets.** Gabl, E.F. (KMS Industries, 700 KMS Place, Ann Arbor, Michigan 48106 (USA)); Failor, B.H.; Armentrout, C.J.; Delamater, N.D.; Fechner, W.B.; Bosch, R.A.; Busch, G.E.; Koenig, Z.M.; Ress, D.; Suter, L. *Physical Review Letters (USA)*, 63(25): 2737-2740 (18 Dec 1989). DOE Contract AC03-87DP10560.

We have observed plasma jets from laser-irradiated gold disk targets. The structures originate from low-intensity regions of the incident laser beam but propagate much faster than similar density surfaces from higher-intensity regions. The material is both cold and dense, as evidenced by its emission of soft x rays and absorption of hard x rays.

25182 **Filamentation and second-harmonic emission in laser-plasma interactions.** Young, P.E. (University of California, Lawrence Livermore National Laboratory, Livermore, California 94550 (USA)); Baldis, H.A.; Johnston, T.W.; Kruer, W.L.; Estabrook, K.G. *Physical Review Letters (USA)*, 63(26): 2812-2815 (25 Dec 1989). DOE Contract W-7405-ENG-48.

Interferograms of an underdense, preformed plasma which is irradiated with a line-focused laser beam show pronounced density perturbations. The interferograms are compared to simultaneous, gated images of second-harmonic emission. We observe a correlation between the spatial positions of the density perturbations and the peak of the second-harmonic emission. We interpret these phenomena as being emission from a local, nonlinear focus in the underdense plasma, rather than from the entire length of a filament.

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Refer also to citation(s) 23992, 24272, 24282, 25153, 25155

25183 (CEA-CONF–9874) **Parametric study of hydrogen permeation rate through Pd-Ag membrane in the presence of gaseous impurities.** Chabot, J.; Lecomte, J.; Grumet, C.; Sannier, J. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Chimie Appliquee et d'Etudes Analytiques. 1988. 5p. (CONF-880929–: 15. symposium on fusion technology (SOFT-15), Utrecht (Netherlands), 19-23 Sep 1988). Order Number DE90762030. Available from NTIS (US Sales Only), PC A02/MF A01.

A parametric study of H_2 permeation rate through Pd-Ag membrane in the presence of gaseous impurities, such as CO, CO_2 and CH_4 is carried out in the loop PALLAS, in a wide range of membrane temperature (100 to 450°C), H_2 pressure (0.3 to 14 kPa) and impurity concentration (0.2 to 9.5 vol.%). CO_2 and CH_4 appear to have no practical effect on the permeation rate whereas a poisoning effect may occur with CO, depending on its concentration and the membrane temperature. However the permeation rate is not affected between 250°C and 375°C.

25184 (CEA-CONF–9875) **Compatibility problems with beryllium in ceramic blankets.** Terlain, A.; Herpin, D.; Perodeaud, P.; Flament, T.; Sannier, J. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Chimie Appliquee et d'Etudes Analytiques. 1988. 5p. (CONF-880929–: 15. symposium on fusion technology (SOFT-15), Utrecht (Netherlands), 19-23 Sep 1988). Order Number DE90762032. Available from NTIS (US Sales Only), PC A02/MF A01.

Compatibility of beryllium with structural materials (316L austenitic steel and 1.4914 martensitic steel) and with tritium breeding ceramics (lithium aluminate or silicate) has been studied in contact tests between 550°C and 700°C and for durations reaching 3000 hours. Beryllium-ceramic interaction is negligible in all the temperature range with aluminate and up to 600°C with silicates. On the other hand, noticeable interaction is observed between beryllium and 316L steel at 580°C and above. Beryllium interaction with 1.4914 steel is visible only at 650°C and above and its amplitude is lower than 316L steel one. In these two cases, the superficial layer is brittle, and adherent to the steel. Comparison between beryllium - 0.4 wt% calcium alloy and beryllium at 700°C shows that interaction with steels or ceramics is qualitatively the same but slightly weaker.

25185 (CEA-CONF–9876) **Corrosion of martensitic steels in flowing 17Li83Pb alloy.** Flament, T.; Fauvet, P.; Hocde, B.; Sannier, J. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Chimie Appliquee et d'Etudes Analytiques. 1988. 5p. (CONF-880929–: 15. symposium on fusion technology (SOFT-15), Utrecht (Netherlands), 19-23 Sep 1988). Order Number DE90762031. Available from NTIS (US Sales Only), PC A02/MF A01.

Corrosion of three martensitic steels - 1.4914, HT9 and T91 - in the presence of flowing 17Li83Pb is investigated in thermal convection loops Tulip entirely made of 1.4914 steel. Two 3000-hour tests were performed at maximal temperatures of respectively 450 and 475°C with a δT of 60°C and an alloy velocity of about 0.08 $m.s^{-1}$. In both tests, corrosion is characterized by an homogeneous dissolution of the steel without formation of a corrosion layer. Corrosion rate is constant and very temperature dependent: the sound-metal loss of 1.4914 steel is 22 $\mu m.\ year^{-1}$ at 450°C and 40 $\mu m.year^{-1}$ at 475°C. Behaviours of 1.4914 and HT9 steels are very similar whereas T91 steel is about 20% less corroded.

25186 (DOE/DP/40200–81) **University of Rochester Laboratory for Laser Energetics annual report, 1 October 1987–30 September 1988.** Rochester Univ., NY (USA). Lab. for Laser Energetics. Jan 1989. 202p. Sponsored by U.S. DOE Defense Programs; New York State Energy Research and Development Authority; Rochester University. DOE Contract FC03-85DP40200. Order Number DE90008673. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

This report discusses progress in laser fusion. Topics in advanced technology developments, national laser users facility news, and laser system report are contained in this report. (LSP)

25187 (DOE/DP/40200–110) **University of Rochester Laboratory for Laser Energetics annual report, 1 October 1988–30 September 1989.** Rochester Univ., NY (USA). Lab. for Laser Energetics. Jan 1990. 236p. Sponsored by U.S. DOE Defense Programs; New York State Energy Research and Development Authority; Rochester University. DOE Contract FC03-85DP40200. Order Number DE90008674. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

This report discusses progress in laser fusion. Topics in advanced technology developments, national laser users facility news, and laser system report are contained in this report. This report also discusses developments and upgrades at the OMEGA facility. (LSP)

25188 (DOE/DP/40200–120) **Time-resolved spectroscopy of nonequilibrium ionization in laser-produced plasmas.** Marjoribanks, R.S. Rochester Univ., NY (USA). Lab. for Laser Energetics. Mar 1990. 198p. Sponsored by U.S. DOE Defense Programs. DOE Contract FC03-85DP40200. Order Number DE90008663. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

The highly transient ionization characteristic of laser-produced plasmas at high energy densities has been investigated experimentally, using x-ray spectroscopy with time resolution of less than 20 ps. Spectroscopic diagnostics of plasma density and temperature were used, including line ratios, line profile broadening and continuum emission, to characterize the plasma conditions without relying immediately on ionization modeling. The experimentally measured plasma parameters were used as independent variables, driving an ionization code, as a test of ionization modelling, divorced from hydrodynamic calculations. Several state-of-the-art streak spectrographs, each recording a fiducial of the laser peak along with the time-resolved spectrum, characterized the laser heating of thin signature layers of different atomic numbers imbedded in plastic targets. Spherical targets were illuminated uniformly with the OMEGA 351 nm laser system, to approximate a one-dimensional homogeneous plasma. A novel design of crystal spectrograph, with a conically curved crystal, was developed. Coupled with a streak camera, it provided high resolution and a collection efficiency roughly 20–50 times that of planar crystal spectrographs, affording improved spectra for quantitative reduction and greater sensitivity for the diagnosis of weak emitters. A novel temperature diagnostic was developed, using special targets with a known proportion of elements: analogous emission lines from

isoelectronic charge-states were used to provide a temperature-sensitive diagnostic ratio. Experimental results were compared to hydrocode and ionization code simulations, with poor agreement. The conclusions question the appropriateness of describing electron velocity distributions by a temperature parameter during the time of laser illumination and emphasize the importance of characterizing the distribution more generally.

25189 (ECN–224) **EXOTIC: Development of ceramic tritium breeding materials: Annual progress report 1988.** Kwast, H.; Conrad, R.; Preston, S. Netherlands Energy Research Foundation, Petten (Netherlands). Sep 1989. 63p. Order Number DE90706067. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

In this fifth EXOTIC annual progress report the work carried out in 1988 is reported. For EXOTIC-1, –2 and –3 the post-irradiation examinations have been continued with tritium retention measurements, annealing experiments, determination of physical and mechanical properties and X-ray diffraction analysis. Irradiation of EXOTIC-4 has been performed and the post-irradiation examination has started. Transient tritium release curves are given and analysed. The resulting tritium residence time of less than one day can be achieved in the temperature region of 350–600C. The loading scheme, the objectives and some fabrication data of EXOTIC-5 are give. Moreover, the fabrication of laboratory scale batches has started to investigate the effect of microstructural parameters on tritium release. Finally, an investigation was started on the systems Li^2O-ZrO^2, with emphasis on the lithiarich compositions. 40 figs.; 9 refs.; 10 tabs. [Data]

25190 (IAEA-TECDOC–536, pp. 83-88) **Power and particle control for ITER.** Sugihara, M. (Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)). ITER Physics Team. International Atomic Energy Agency, Vienna (Austria). Jan 1990. (CONF-8902101–: IAEA technical committee meeting on impurity control, Naka (Japan), 13-15 Feb 1989). In *Impurity control in toroidal devices: Proceedings of a technical committee meeting held in Naka-Gun, Japan, 13-15 February 1989.* Order Number DE90618585. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

The poloidal divertor is presently the most credible concept for the exhaust of the plasma power and helium ash and also for the control of impurities in ITER. Substantial localized recycling will occur within the divertor thereby ensuring a relatively low plasma temperature at the plate, good retention of eroded material. Nevertheless, the ITER divertor plasma conditions will be very demanding with respect to power loading, erosion of plate material, and pumping of helium ash. It is predicted that operation at low $<n_e>$ (e.g. $\leq 10^{20}/m^3$) or with strongly peaked density profiles can raise the divertor plasma temperature to such an extent that the sputtering rate of high Z plate materials would be unacceptable. This has led to the initial choice of low Z (e.g. carbon or carbon based) materials. Divertor plate material for the technology phase will be chosen based on the experiments during the initial physics phase and on other experimental data. However, the net erosion rates of carbon are high even when allowance is made for redeposition. There is thus a strong incentive to use refractory metals by reducing the divertor plasma temperature either by increased edge radiation or by operation at increased density, which conflicts with the requirements for efficient current drive. Model calculations show that the pumping requirements for helium neutral gas are very demanding, e.g. well in excess of 100 m^3/s. Solving these erosion and impurity control problems is one of the most serious and demanding technical issues of the ITER design. (author). 3 refs.

25191 (NEANDC–259-U) **Proceedings of a Specialists' meeting on neutron activation cross sections for fission and fusion energy applications.** Wagner, M. (Vienna Univ. (Austria). Inst. fuer Radiumforschung und Kernphysik); Vonach, H. (eds.). OECD Nuclear Energy Agency, Paris (France). c [1989]. 346p. (CONF-890982–: Specialists' meeting on neutron activation cross sections for fission and fusion energy applications, Argonne, IL (USA), 13-15 Sep 1989). Available from Organisation for Economic Co-operation and Development, 2, rue Andre-Pascal, 75775 Paris Cedex 16, France.

This report contains papers on neutron dosimetry, neutron radiation damage, and the production of long-lived activities in fission and fusion reactors. These papers have been processed separately. (LSP)

25192 (ORNL/FTR–3557) **[The international thermonuclear experimental reactor (ITER) workshop on plasma facing components and materials data base]: Foreign trip report, January 26–February 10, 1990.** Burchell, T.D. Oak Ridge National Lab., TN (USA). 23 Mar 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008885. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This report summarizes the results of the Plasma Facing Components Workshop and the Specialist Meeting on ITER Material Data Base which were held at ITER winter session at Garching, Federal Republic of Germany (FRG). Those areas of relevance to the Oak Ridge National Laboratory (ORNL) fusion graphite and carbon-carbon composite program are described in more detail.

25193 (PNL-SA–16981) **The relative influence of helium/dpa ratio and other variables on neutron-induced swelling of Fe-Ni-Cr alloys at 495°C and 14 dpa.** Stubbins, J.F. (Illinois Univ., Urbana, IL (USA)); Garner, F.A. Pacific Northwest Lab., Richland, WA (USA). Dec 1989. 13p. Sponsored by U.S. DOE Energy Research; Northwest College and University Association for Science. DOE Contract AC06-76RL01830. (CONF-891204–26: 4. international conference on fusion reactor materials, Kyoto (Japan), 4-8 Dec 1989). Order Number DE90008621. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

An isotopic tailoring experiment utilizing ^{59}Ni has been conducted in the Fast Flux Test Facility (FFTF) to study the influence of helium/dpa ratio on neutron-induced microstructural evolution. The influence of other variables, namely composition (nickel and phosphorous variations) and cold work on swelling was also examined. The alloys Fe-25Ni-15Cr, Fe-25Ni-15Cr-0.04P, and Fe-45Ni-15Cr were each irradiated in four conditions: solution annealed or 20% cold worked both with and without the ^{59}Ni additions yielding He/dpa ratios of 0.35 and 4.7 at 25Ni and 0.57 and 4.9 at 45Ni. Increases in helium were found to alter the details of microstructural evolution somewhat at 495°C, but the effect of helium was small compared to the effects of other variables studied. 15 refs., 4 figs.

25194 (PPPL-Q–46) **[Fusion energy research]: Annual report, October 1, 1987–September 30, 1988.** Phillips, C.A. (ed.). Princeton Univ., NJ (USA). Plasma Physics Lab. 1988. 158p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE90008662. Available from NTIS, PC A08/MF A01; OSTI; INIS; GPO Dep.

This report discusses the following topics: principal parameters achieved in experimental devices (FY88); tokamak fusion test reactor; Princeton beta Experiment-Modification; S-1 Spheromak; current drive experiment; x-ray laser studies; spacecraft glow experiment; plasma deposition and etching of thin films; theoretical plasma; tokamak modeling; compact ignition tokamak; international thermonuclear experimental reactor; Engineering Department; Project Planning and Safety Office; quality assurance and reliability; and technology transfer.

25195 **Theory and design of a harmonic Ubitron/Free-Electron laser.** Freund, H.P. (Science Applications International Corp., McLean, VA (USA)); Bluem, H.; Jackson, R.H. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

A fully three-dimensional nonlinear analysis of the harmonic Ubitrono/Free-Election laser is discussed which is valid for arbitrary harmonic number. The analysis has been performed for a configuration consisting of a beam propagating through a loss-free rectangular waveguide in the presence of a planar wiggler field. The wiggler model includes an adiabatic entry taper to model the injection of the beam into the wiggler, parabolic pole pieces to provide additional focussing in the plane normal to the wiggler, and an amplitude taper downstream from the entry region for efficiency enhancement. The advantage of harmonic operation is that relatively high operating frequencies may be obtained with relatively modest beam energies; however, this occurs at the expense of a greater

sensitivity to beam thermal effects. In addition to enhancing the extraction efficiency, a tapered wiggler has been shown to reduce the sensitivity of the interaction to thermal effects. Thus, the tapered wiggler is designed to counter the increased thermal sensitivity of the harmonic interaction. Suppression of the fundamental is accomplished by the careful choice of the beam energy, waveguide radius, and wiggler period in order to ensure that no resonance is possible at the fundamental. Specific design criteria for a third harmonic experiment operating at 15 GHz with a 55 keV electron beam are discussed.

25196 Soviet research on intense-relativistic-electron-beam, microwave sources. Granatstein, V.L. (Maryland Univ., College Park, MD (USA)). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

A recent assessment of Soviet high power microwave research is summarized and updated. Topics discussed include: backward-wave oscillators (BWOs) at x-band and κ_a-band in circuits with diameter much larger than the wave-length. Results include generation of a 15 GW, 60 ns pulse of x-band radiation with 50% efficiency; repetitively-pulsed BWOs and magnetrons, compact packaging of these sources, and their possible applications; and gyrocon amplifiers and frequency doublers for driving linear supercolliders. Results include demonstration of a 60 dB amplifier with output frequency of 7 GHz and output power of 60 MW in 700 ns pulses.

25197 Phase locking of high power oscillators. Benford, J. (Physics International Co., San Leandro, CA (USA)). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

High power microwave sources have been developed in recent years to power levels of 1-10 GW. Extension of power to higher levels is inhibited by limits on the electric field in the resonator, and limits on cavity size (mode competition). Therefore, for very high powers, groups of sources locked together in phase to achieve constructive interference is the likely approach. When phase locking of N oscillators is used, total power scales with N, and power density with N^2 due to increased antenna area. Recent experiments are described which show phase locking of relativistic magnetrons and high power vircators in the regime of 1-3 GW. An alternative to oscillator arrays is a master oscillator, power amplifier approach using relativistic klystrons or TWT's. The salient features of oscillator and amplifier approaches will be described.

25198 Simulation of long time scale plasma opening switches. Mason, R.J. (Los Alamos National Lab., NM (USA). Applied Theoretical Physics Div. (USA)). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The 2-D implicit ANTHEM code has been used to examine the feasibility of plasma opening switch operation at conduction times ranging from 500 ns to 3 μsec. The classical bi-cylindrical switch is examined with a cathode radius of 8 cm, an anode radius of 11.5 cm, and a plasma length of 20 cm - as typical dimensions. The generator current rises linearly to 1 MA. The plasma dynamics of operation are described for fill electron number densities from 10^{13} to 10^{15} cm^{-3}, and for loads ranging from a short circuit to 5 Ohms.

25199 Simulation of plasma generation by microwave power beaming. Koert, P. (ARCO Power Technologies, Inc. (US)); Lallement, P. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Plasma generation in the atmosphere by microwave power beaming is an integral part in the design of a RF transmission system which uses a plasma cloud as a reflector. The microwave breakdown of air through avalanche ionization is simulated on a computer. Focusing techniques using large heater array antennas are explored and evaluated in their ability to create a plasma cloud at prescribed location and inclination. These techniques include frequency chirping, random thinning of the heater array, discrete vertical scanning and use of multiple heater pulses. The effect of these techniques on the shape, intensity and gradient of the plasma cloud is shown. An analysis of irregularities in the plasma cloud is presented.

25200 Electron diode oscillators for high-power RF generation. Humphries, S. (New Mexico Univ., Albuquerque, NM (USA). Dept. of Electrical and Computer Engineering (USA)). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Feedback oscillators have been used since the invention of the vacuum tube. This paper describes the extension of these familiar circuits to the regime of relativistic electron beam diodes. Such devices have potential application for the generation of high power RF radiation in the range 50-250 MHz, 1-10 GW with 20-60% conversion efficiency. This paper reviews the theory of the oscillator and the results of a design study. Calculations for the four-electrode diode with EGUN and EBQ show that good modulations of 30 kA electron beam at 600 kV can be achieved with moderate field stress on the electrodes. Conditions for oscillation have been studied with an in-house transmission line code. A design for a 7.5 GW oscillator at 200 MHz with 25% conversion efficiency is presented.

25201 Simulation of a 41 cavity MILO. Marder, B.M. (Sandia National Labs., Albuquerque, NM (USA)). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The MILO high power microwave device consists of a cylindrical cathode surrounded by a vaned anode between which flows a magnetically self-insulated electron beam. This interacts with the anode structure to produce microwave oscillations. The current consists of two parts, that which flows within the AK gap, and that which flows in the cathode, ultimately crossing in a load region away from the anode structure. Most of the current flowing in the gap reaches the anode in electron spokes similar to those seen in magnetrons. Earlier MILO designs contained ten cavities. In the configuration, 20% of the current flowed in the gap while 80% remained in the cathode, expending its energy uselessly (except for providing the required magnetic field) in the load region. Simulations of MILO with 41 cavities are presented. They show that three-quarters of the current crosses in the spokes, leaving only one-quarter to be dumped in the load. Furthermore, the 40% conversion efficiency appears to be maintained, giving an overall efficiency of 30%.

25202 Implementation of a parallel 3-D vacuum electronics simulation code. Zaidman, E. (Naval Research Lab., Washington, DC (USA)). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors report a three-dimensional electromagnetic particle-in-cell simulation code implemented on the NRL Connection Machine-2. Both the internal code structure and the user input/output interface implementation aspects are discussed. Internally, standard algorithms are used as much as possible, but in a parallel formulation. To advantageously use the parallel machine architecture, which includes a large local memory at each processor, optimized nearest neighbor communication and flexible hypercube communication, certain new algorithms have been applied. A fully parallel particle push uses local storage of the fields predetermined

at the particle positions. The field calculations use a nearest neighbor communication constraint overlaid upon an interpolating matrix method solver with an irregular spatial mesh. The gather/scatter uses the hypercube communication network and limits the effect of nonuniform computational loading. External to the core calculation is real time video output of diagnostic graphics via a hardware integrated frame buffer, or, optionally, Tektronix or X-Window protocols, provides rapid feedback to the simulator with a goal of the implementation being an interactive simulation environment.

25203 **Circuit description of inductive energy storage pulsed power systems.** Kung, C.C. (Maryland Univ., College Park, MD (USA). Dept. of Electrical Engineering); Rhee, M.J. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Recent development of fast opening switch technology has led to this circuit study of the inductive energy pulsed power systems. In this paper, a comprehensive circuit analysis of basic inductive energy pulsed power systems has been carried out. It is noted that the circuit of system with inductive energy storage is the dual of that with capacitive energy storage. In the most of practical systems, the inductive energy is stored in a lumped inductor by a slow current charging and then rapidly released to a load by means of an opening switch. Such a system may be practical for generation of relatively slow output pulse. It is shown that as in the capacitive systems, a fast square pulse can be produced by using a transmission line as an energy storage in lieu of the lumped inductor, resulting in a high power multiplication. In addition, the authors propose other inductive energy circuits which may be useful for practical applications. These are the duals of well known capacitive energy circuits such as the LC generator and the Blumlein line. The output pulse waveforms, with relevant circuit parameters, are derived for a number of basic inductive energy storage circuits.

25204 **Simulation of RF reflection from slightly irregular plasma sheets.** Wallace, T. (ARCO Power Technologies, Inc. (US)); Short, R.; Papadopoulos, K. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The effects of small magnitude irregularities of a variety of characteristic scales on the reflective properties of sheets of highly collisional plasma are of interest in the design of a RF transmission system which employs these sheets as reflectors. The phase perturbation of the reflected wavefront induced by the presence of these irregularities is calculated using both a ray based perturbational approach and a finite-difference full wave technique. In this paper, the effects of absorption within the plasma sheet on the phase perturbation are examined and found to be small. The results of the two techniques are compared for a wide range of irregularity scales and several values of ν/ω, yielding a prescription for choosing a technique depending on the ratio of incident wavelength to irregularity scale and plasma layer depth. The effect of the phase perturbation on the shape and intensity of the reflected RF beam is calculated, and the contribution of the irregularities is compared to RF beam distortion and attenuation due to diffraction and collisional absorption.

25205 **Distribution of flux-pinning energies in $YBa_2Cu_3O_{7-\delta}$ and $Bi_2Sr_2CaCu_2O_{8+\delta}$ from flux noise.** Ferrari, M.J. (Department of Physics, University of California, Berkeley, CA (USA)— Center for Advanced Materials, Materials and Chemical Sciences Division, Lawrence Berkeley Laboratory, 1 Cyclotron Road, Berkeley, California 94720 (USA)); Johnson, M.; Wel *Physical Review Letters (USA),* 64(1): 72-75 (1 Jan 1990). DOE Contract AC03-76SF00098.

The spectral density of the magnetic flux noise measured in high-temperature superconductors in low magnetic fields scales approximately as the inverse of the frequency and increases with temperature. We use the temperature and frequency dependence of the noise to determine the pinning energies of individual flux vortices in thermal equilibrium. The distribution of pinning energies peaks below 0.1 eV in $YBa_2Cu_3O_{7-\delta}$ and near 0.2 eV in $Bi_2Sr_2CaCu_2O_{8+\delta}$. The noise power is proportional to the ambient magnetic field, indicating that the vortex motion is uncorrelated.

25206 **Reply to the comments of Drake.** Simon, A. (Laboratory for Laser Energetics, University of Rochester, 250 East River Road, Rochester, New York 14623-1299 (US)); Short, R.W. *Physics of Fluids B (USA),* 2(1): 227-228 (Jan 1990).

There are three issues in Drake's comment. The first raises questions about the angular distribution predicted by our theory at lower laser intensities. It is shown that the qualitative behavior should be in accord with existing observations, but that a detailed comparison will require experimental data that is not yet available. The second is about the relative timing of the Raman scattering and disappearance of the quarter-critical surface. It is noted that existing measurements have considerable uncertainty and that there are additional complications for an exploding foil target. The last comment, about the probability of our power flow, is simply an opinion about a conjecture.

25207 **Illumination uniformity of spherical targets using kilojoule-scale lasers with optical smoothing.** Colombant, D.G. (Plasma Physics Division, Naval Research Laboratory, Washington, D.C. 20375 (USA)); Schmitt, A.J. *Journal of Applied Physics (USA),* 67(5): 2303-2309 (1 Mar 1990).

Illumination uniformity in laser-pellet interactions is investigated for small kilojoule-range laser systems that are capable of symmetrically illuminating spherical targets. We address a variety of options that might be used to control the illumination uniformity on such targets, including the number of beams, pulse energy, laser wavelength, temporal pulse shape, and beam spatial profile shape. We consider only laser beams that are optically smoothed using methods such as induced spatial incoherence or random phase plates. The parameters that are most important for providing good uniformity are identified. We find that the most important parameters governing the uniformity are the number of beams and the shape of the beam profile. Configurations with a small number of beams (e.g., six) are much more sensitive to the beam profile; using techniques such as splitting the focal spots provides an additional degree of freedom that can significantly increase the illumination uniformity. Additionally, we show that the hydrodynamics of the plasma is important in determining the uniformity, although it is not so easily controlled. Quantitatively, we find nonuniformities (measured by peak-to-valley ablation pressure differences) can be less than 10% for six-beam kilojoule-level 1/4 -μm laser wavelength systems, and of the order of a few percent for comparable 24-beam systems.

99 GENERAL AND MISCELLANEOUS

25208 (IJS-P–300) **Jozef Stefan Institute annual report for 1986.** Gams, M. (ed.). Institut Jozef Stefan, Ljubljana (Yugoslavia). Jun 1987. 129p. (In Slovenian). Order Number DE90622160. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

This report presents the main features of the Josef Stefan Institute work in the course of the year 1986. The research projects and activities of the Institute are described in detail in the following fields: physics (theoretical, nuclear, solid state and reactor physics), chemistry (nuclear, physical, analytical, high temperature, fluorine chemistry, ceramics and biochemistry), electronics (automation, biocybernetics, robotics, computer science and information science, energy and process control and professional electronics), reactor engineering and safety, and applied mathematics and many interdisciplinary projects resulting from these fields. Special attention is paid to those fields and programmes which are important to the growth and development of the national economy. In addition, the operational structure of the Institute and its budget are also mentioned. The document contains a list of the project titles which the Institute coordinates. There is another list of printed material (journal articles, thesis, conference papers, etc.) written by researchers of the Institute. (Z.Z.). 1143 refs.

25209 (IJS-P–301) **Annual report of the Jozef Stefan Institute for 1987.** Gams, M. (ed.). Institut Jozef Stefan, Ljubljana (Yugoslavia). Jun 1988. 207p. (In Slovenian). Order Number

DE90622161. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

This report presents the main features of the Josef Stefan Institute work in the course of the year 1987. The research projects and activities of the Institute are described in detail in the following fields: physics (theoretical, nuclear, solid state and reactor physics), chemistry (nuclear, physical, analytical, high temperature, fluorine chemistry, ceramics and biochemistry), electronics (automation, biocybernetics, robotics, computer science and information science, energy and process control and professional electronics), reactor engineering and safety, and applied mathematics and many interdisciplinary projects resulting from these fields. Special attention is paid to those fields and programmes which are important to the growth and development of the national economy. In addition, the operational structure of the Institute and its budget are also mentioned. The document contains a list of the project titles which the Institute coordinates. There is another list of printed material (journal articles, thesis, conference papers, etc.) written by researchers of the Institute. (Z.Z.). 1260 refs.

9901 Management

Refer also to citation(s) 23774, 25252

25210 (CSIR-SP-SFIS–5) **Annual report July 1985 - June 1986.** Council for Scientific and Industrial Research, Pretoria (South Africa). National Physical Research Lab. 1986. 123p. Available from the National Physical Research Laboratory, PO Box 395, Pretoria, 0001, South Africa. Available from the National Physical Research Laboratory, PO Box 395, Pretoria, 0001, South Africa.

This annual report reviews the activities of the National Physical Research Laboratory from July 1985 to June 1986. These activities included, inter alia: the application of acoustic principles to solve a problem in the steel industry; the improvement of calibrations and calibration standards; the determination of radiometric ages for a number of geological formations in Southern Africa and isotope studies of archaeological samples of animal and human bone. Separate abstracts were prepared for two of the subdivisions in this report. The remaining subdivisions were considered outside the subject scope of INIS.

25211 (DOE/RL–89-31/) **Hanford Site Infrastructure Plan.** USDOE Richland Operations Office, WA (USA). Jan 1990. 209p. Sponsored by U.S. DOE Nuclear Energy. Order Number DE90008034. Available from NTIS, PC A10/MF A01; OSTI; INIS; GPO Dep.

The Hanford Site Infrastructure Plan (HIP) has been prepared as an overview of the facilities, utilities, systems, and services that support all activities on the Hanford Site. Its purpose is three-fold: to examine in detail the existing condition of the Hanford Site's aging utility systems, transportation systems, Site services and general-purpose facilities; to evaluate the ability of these systems to meet present and forecasted Site missions; to identify maintenance and upgrade projects necessary to ensure continued safe and cost-effective support to Hanford Site programs well into the twenty-first century. The HIP is intended to be a dynamic document that will be updated accordingly as Site activities, conditions, and requirements change. 35 figs., 25 tabs.

25212 (PPA-AR–3.2) **Activities of the research division 1986.** Unit Tenaga Nuklear, Bangi, Selangor (Malaysia). Jun 1987. 266p. (In English, Malay). Order Number DE90622165. Available from NTIS (US Sales Only), PC A12/MF A01; OSTI; INIS.

The brief report of activities of the Research Divisions of Nuclear Energy Unit 1986 is presented. (author).

25213 (PPA-AR–13.1) **Activities of the research division 1985.** Unit Tenaga Nuklear, Bangi, Selangor (Malaysia). Mar 1986. 159p. (In English, Malay). Order Number DE90622162. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

The brief report of activities of the Research Divisions of Nuclear Energy Unit in 1985 is presented. (author).

25214 (PPA-AR–13.3) **Activities of the research division 1987.** Unit Tenaga Nuklear, Bangi, Selangor (Malaysia). Jul 1988. 170p. (In English, Malay). Order Number DE90622163. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

This is the brief report of the activities of the Research Division of Nuclear Energy Unit in 1987. (author).

25215 (PPA-AR–13.4) **Activities of the research division 1988.** Zahrah Binti Abdul Kader; Alawiah Binti Musa; Asiah Binti Ahmad; Kok Kuan Ying. Unit Tenaga Nuklear, Bangi, Selangor (Malaysia). Jun 1989. 225p. (In English, Malay). Order Number DE90622164. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

The brief report of activities of the Research Divisions of Nuclear Energy Unit in 1988 is presented. (author).

25216 (PPA-AR–19.2) **Activities of the operations division 1987.** Unit Tenaga Nuklear, Bangi, Selangor (Malaysia). Mar 1989. 154p. (In English, Malay). Order Number DE90622155. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

The brief report of activities of the Operations Division of Nuclear Energy Unit in 1987 is presented. (author).

9902 Mathematics and Computers

Refer also to citation(s) 23412, 23484, 23485, 23568, 23576, 23604, 23622, 23625, 23626, 23630, 23739, 23741, 23742, 23743, 23756, 23778, 23779, 23786, 23788, 23794, 23843, 23855, 23872, 23886, 23893, 23923, 23924, 23925, 23926, 23927, 23928, 23929, 23930, 23931, 23932, 23933, 23934, 23935, 23936, 23957, 23962, 24007, 24102, 24103, 24142, 24147, 24183, 24186, 24187, 24189, 24218, 24240, 24256, 24282, 24293, 24311, 24315, 24328, 24334, 24338, 24340, 24344, 24381, 24383, 24421, 24422, 24821, 24842, 24849, 24850, 24893, 24972, 25034, 25202, 25250, 25252, 25253, 25254

25217 (AD-A–215105/8/XAB) **Dynamic reconfiguration and link fault tolerance in a transputer network. Master's thesis.** Pikelis, W.P. Naval Postgraduate School, Monterey, CA (USA). Jun 1989. 161p. Available from NTIS, PC A08/MF A01.

This thesis explores dynamic reconfiguration and link fault tolerance in a Transputer network using software controlled crossbars. A message exchange system was designed, implemented and evaluated to facilitate various aspects of dynamic interconnectivity between processing nodes, as well as detection and recovery from failed network links without loss of data. As implemented, the message exchange can be embedded with application code which can direct network topology to facilitate code execution.

25218 (AD-A–215108/2/XAB) **Transitive reduction in parallel via branchings.** Gibbons, P.; Karp, R.; Ramachandran, V.; Soroker, D.; Tarjan, R. Princeton Univ., NJ (USA). Dept. of Computer Science. 15 Jul 1988. 17p. (CS-TR–171-88). Available from NTIS, PC A03/MF A01.

We study the following problem: given a strongly connected digraph, find a minimal strongly connected spanning subgraph of it. Our main result is a parallel algorithm for this problem, which runs in polylog parallel time and uses O(n cubed) processors on a PRAM. Our algorithm is simple and the major tool it uses is computing a minimum-weight branching with zero-one weights. We also present sequential algorithms for the problem that run in time O(m+n.logn).

25219 (AD-A–215113/2/XAB) **Parallel algorithm for finding a blocking flow in an acyclic network.** Goldberg, A.V.; Tarjan, R.E. Princeton Univ., NJ (USA). Dept. of Computer Science. Oct 1988. 11p. (CS-TR–186-88). Available from NTIS, PC A03/MF A01.

We suppose a simple parallel algorithm for finding a blocking flow in an acyclic network. On an n-vertex, m-arc network, our algorithm runs in O(n log n) time and O(nm) space using an m-processor EREW PRAM. A consequence of our algorithm is an O(n2(log n)log(nC))-time, O(nm)-space, m-processor algorithm for the minimum-cost circulation problem, on a network with integer arc capacities of magnitude at most C.

25220 (AD-A–215136/3/XAB) **Large-scale optimization via distributed systems. Final report, July 1986-June 1989.** Meyer, R.R. Wisconsin Univ., Madison, WI (USA). Dept. of Computer Sciences. 1 Nov 1989. 9p. Available from NTIS, PC A02/MF A01.

Most large-scale network optimization problems exhibit structures that allow the possibility of attack via algorithms that exhibit a high degree of parallelism. Such structures include quasi-independent blocks of constraints for different commodities or time periods, and geographically disjoint components in approximating solutions. The emphases of our research have been the development of new parallel optimization techniques that utilize these and related features in order to take advantage of distributed computing environments. We have also undertaken a comparison of the relative efficiencies of approaches based on different computer architectures such as message-passing multicomputers and shared-memory multiprocessors. The parallel algorithms that we have implemented have made possible the solution of extremely large linear networks (with more than 1 million variables) and nonlinear network optimization problems with as many as 400,000 variables or relatively modest parallel computing systems, and have displayed excellent speedups relative to the corresponding single-processor programs.

25221 (AD-A–215190/0/XAB) **Critical problems in very-large-scale computer systems. Semiannual technical report, 1 April-30 September 1989.** Agarwal, A.; Dally, W.J.; Devadas, S.; Knight, T.F.; Leighton, F.T. Massachusetts Inst. of Tech., Cambridge, MA (USA). 30 Sep 1989. 59p. Available from NTIS, PC A04/MF A01.

The research vehicle for this contract is the largest possible computer that could be conceived for the mid to late 1990's. The technical challenges of such a machine serve as our guiding stimulus for the research carried out and reported here. We imagine this machine to occupy a 14-story building, to cost upward of $1 billion, and to be so colossal that the nation could only afford one or two of them. The available chip technology and machine size are consistent with 10 to the 15th power FLOPS and 10 to the 15th power bytes of memory. The machine will be used to solve large-scale scientific problems having both military and civilian applications. This investigation addresses the hardware technology, software techniques, algorithms, communications, processing elements, and applications. The study will determine the plausibility (not feasibility) of the machine. Progress in these various areas are highlighted in the forthcoming sections. (rrh)

25222 (AD-A–215399/7/XAB) **Optimal selection theory for superconcurrency. Technical document.** Freund, R.F. Naval Ocean Systems Center, San Diego, CA (USA). Oct 1989. 8p. (NOSC/TD–1669). Available from NTIS, PC A02/MF A01.

This paper describes a mathematical programming approach to finding an optimal, heterogeneous suite of processors to solve supercomputing problems. This technique, called superconcurrency, works best when the computational requirements are diverse and significant portions of the code are not tightly-coupled. It is also dependent on new methods of benchmarking and code profiling, as well as eventual use of AI techniques for intelligent management of the selected superconcurrent suite.

25223 (AD-A–215403/7/XAB) **Design for a real-time high-quality volume-rendering work station.** Levoy, M. North Carolina Univ., Chapel Hill, NC (USA). Dept. of Computer Science. May 1989. 7p. Available from NTIS, PC A02/MF A01.

Pub. in Chapel Hill Workshop on Volume Visualization Conference Proceedings, 85-90(18-19 May 1989).

A design is presented for a workstation capable of rendering arbitrary mixtures of analytically defined geometry and sampled scalar fields of three spatial dimensions in real-time or near real-time. The design is based on volumetric compositing, a relatively new approach to visualizing scalar fields by computing 2D projections of a colored semi-transparent volume. Geometric primitives are added by filtering and 3D scan-converting them into the data set prior to rendering. Speedups totaling four orders of magnitude over published volumetric compositing techniques are obtained through a combination of algorithmic improvements and hardware implementation of Pixel-planes 5, a massively parallel raster display engine incorporating custom logic-enhanced memory chips. A preliminary design is also presented for a two-handed volume-of-interest data exploration tool.

25224 (AD-A–215628/9/XAB) **Hybrid optical/digital architecture for distortion-invariant pattern recognition. Master's thesis.** Cline, J.D. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Dec 1989. 292p. (AFIT/GEO/ENG–89D-2). Available from NTIS, PC A13/MF A02.

This research investigated optical techniques for pattern recognition. An optical joint transform correlator was implemented using a magneto-optic spatial light modulator, and a charge coupled device (CCD) camera and frame grabber under personal computer (PC) control. A hybrid optical/digital architecture that could potentially perform position, scale, and rotation invariant pattern recognition using a computer generated hologram (CGH) was also implemented. The joint transform correlator was tested using forward looking infrared (FLIR) imagery containing tactical targets, and gave very good results. New techniques for binarizing the FLIR inputs and the fringe pattern of the joint transform were discovered. The input binarization used both scene average and a localized energy normalization technique for binarization. This resulted in reduced scene background, while retaining target detail. The fringe binarization technique subtracted the Fourier transform of the scene from the joint transform, and binarized on the average difference. This new technique was a significant improvement over recent published designs.

25225 (ANL–89/43) **Joint Japanese-American workshop on future trends in logic programming.** Pieper, G.W. (ed.). Argonne National Lab., IL (USA). Dec 1989. 284p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract W-31109-ENG-38. IRI-8915387. (CONF-8910372–: Joint Japanese-American workshop on future trends in logic programming, Argonne, IL (USA), 11-13 Oct 1989). Order Number DE90008343. Available from NTIS, PC A12/MF A01 - OSTI.

This report summarizes the activities related to the Joint Japanese-American Workshop on Future Trends in Logic Programming, which was held at Argonne National Laboratory on October 11–13, 1989. The workshop was organized by the Mathematics and Computer Science Division of Argonne and the Institute for New Generation Computer Technology of Japan, and was sponsored by the National Science Foundation. The objective of the workshop was to review developments and discuss the goals of logic programming. Four main areas were considered: multiprocessing, constraint logic programming, logical foundation of programming, and knowledge representation and database. Here we present abstracts of the sixteen presentations; Section 10 includes more detailed papers on each topic. We also summarize the group discussions that were held informally during the three-day workshop, and the question-and-answer sessions that addressed pertinent issues, such as how logic programming addresses the needs of the software community. An important part of the workshop was the demonstration of the Japanese computer, the Multi-PSI. This report also includes a summary of that demonstration; in Section 11 is a detailed Guide to the Japanese Demonstrations.

25226 (CONF-891273–3) **Parallel tridiagonalization of a general matrix using distributed-memory multiprocessors.** Geist, G.A. Oak Ridge National Lab., TN (USA). [1989]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 4. SIAM conference on parallel processing for scientific computing; Chicago, IL (USA); 11-13 Dec 1989. Order Number DE90008902. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Recently there has been a renewed interest in finding reliable methods for reducing general matrices to tridiagonal form. We have developed a serial reduction algorithm that appears to be very reliable in practice by incorporating an optimal pivot search and two recovery schemes. In this paper we describe a parallel version of our algorithm. The algorithm was developed as one step in the process of finding eigenvalues of nonsymmetric matrices. Our original parallel eigenvalue routines reduced the matrix to Hessenberg form and then applied QR iteration, but the performance of the QR iteration was disappointing. Our new parallel algorithm reduces the matrix to tridiagonal form and then applies LR iteration. Using an iPSC/2, we compare the performance of the new parallel algorithm with our previous parallel algorithm and show that the new algorithm is nearly an order of magnitude faster, allowing us to solve much larger problems than previously attempted. 13 refs., 2 figs.

25227 (CONF-900451–2) **Design and implementation of moment invariants for pattern recognition in VLSI [very large scale integration].** Armstrong, G.A. (Oak Ridge National Lab., TN (USA)); Simpson, M.L.; Bouldin, D.W. Oak Ridge National Lab., TN (USA). [1990]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Technical symposia on optical engineering and photonics in aerospace sensing; Orlando, FL (USA); 16-20 Apr 1990. Order Number DE90008905. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper describes the design of a very large scale integration (VLSI) application specific integrated circuit (ASIC) for use in pattern recognition. The pattern recognition scheme uses Hu and Maitra's algorithms for moment invariants. A prototype design was generated that resolved the long delay time of the multiplier by custom designing adder cells based on the Manchester carry chain. Use of the Manchester carry chain effectively incorporated the lookahead carry function into the adder cells. The prototype ASIC is currently being fabricated in 2.0-mm compiled simulator for metal oxide semiconductor (CMOS) technology (simulated at 20 MHz). The prototype consisted of a 4 x 8 multiplier and a 12-bit accumulator stage. The present ASIC design consists of a 9 x 26 multiplier (maximum propagation time of 50 ns) and a 48-bit accumulator stage. The final ASICs will be used in parallel at the board level to achieve the 56 MegaPixels/s [230 million operations per second (MOPs)] necessary to perform the moment invariant algorithms in real time on 512 x 512 pixel images with 256 grey scales. 11 refs., 3 figs., 7 tabs.

25228 (CONF-900599–4) **Benefits derived from computer integration of complex heat-treat equipment.** Wakefield, K.A.; Gould, S.S. Oak Ridge National Lab., TN (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 36. ISA international instrumentation symposium; Denver, CO (USA); 6-10 May 1990. Order Number DE90008566. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Stringent atmospheric conditions imperative for high-grade metal billet production mandate the use of a furnace system capable of maintaining a high-integrity inert atmosphere during automated insertion, processing, and removal of billets. The computer-integrated manufacturing strategy developed for forming and forging operations will be discussed in this paper. The integrated system includes a rotary hearth furnace, an automated billet-handling system, and inventory tracking, with an associated process control system for operation and integration. This paper will describe furnace system design in detail, and will report a unique strategy for thermocouple selection, temperature control, and power element monitoring by the process controller. The billet-handling system comprises a robotic manipulator, inventory ingress/egress conveyors with precision mechanical positioner and photoelectric monitoring, and a multiple I/O process controller. This paper will discuss the role of the process controller functions of supervision, control, and process monitoring, and input of furnace and all associated subsystem parameters (data, alarms, inventory status, furnace status, etc.) into a general plant production data base system. The integrated system will be presented and discussed to demonstrate the benefits of factory automation from both management and operator perspectives. 4 refs., 5 figs.

25229 (CONF-9005106–Suppl.) **Thirteenth Department of Energy Computer Security Group conference: Security through teamwork: Preliminary conference brochure and program: Supplment.** USDOE, Washington, DC (USA). [1990]. 12p. Sponsored by U.S. DOE Defense Programs. From 13. annual conference of the Computer Security Group; Augusta, GA (USA); 8-10 May 1990. Order Number DE90008141. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The theme of the conference is "Security Through Teamwork," and we have scheduled some very exciting presentations both from within and outside the DOE/Contractor community. this paper contains a list of pre-conference workshops that will be presented at this meeting.

25230 (JINR-R–3-88-767) **About deriving the spectrum correction equation and one method of its solution.** Sen, K.K. (State Committee for Atomic Energy, Pyongyang (D.P.R. of Korea). Research Center for Atomic Energy); Kha, O.S. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics. 1988. 10p. (In Russian). Order Number DE90622144. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A method for processing the apparatus spectra obtained on a multichannel spectrometer is considered. The dependence between standard and real spectra at the spectrometer gain and zero drift is established. Equation of correction is derived from the formula obtained, and one way of its numerical solution is proposed. 13 refs.; 2 tabs.

25231 (JINR-R–10-88-692) **CAMAC crate interface with ES computer via the ES-7922 local group controller.** Krasnoslobodtsev, V.I.; Moroz, V.I. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation. 1988. 8p. (In Russian). Order Number DE90622148. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The interface for data exchange between CAMAC crate and ES computer using ES-7920 local terminal system communication protocol and connected to ES-7922 local group controller via coaxial cable up to 1200 m in length has been developed. The interface is described for OS ES as ES 7927 display terminal. Data can be transferred at maximum speed up to 20 kbyte/s(using a modified ES-7922 controller-up to 40 kbyte/s). There were realized measures to exclude data stream collisions between CAMAC crate controller and ES-7922 controller having different timing. 5 refs.; 1 fig.; 2 tabs.

25232 (JINR-R–11-88-716) **Program realization of Krylov-Bogolyubov averaging method in high approximations applied to the system of two nonlinear second order differential equations with periodic coefficients: For equations with linear part having constant coefficients.** Zhidkova, I.E. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 3p. (In Russian). Order Number DE90622141. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The program package for Krylov-Bogolyubov averaging method in high approximations applied to the system of two nonlinear second order differential equations with the periodic coefficients is described. The possibilities of programs, global algorithm, time and central processor memory estimations are done for equations which have the constant coefficients before its linear part. 7 refs.

25233 (JINR-R–11-88-722) **Program realization of Krylov-Bogolyubov averaging method in high approximations applied to the system of two nonlinear second order differential equations with periodic coefficients: For equations with linear part having periodic coefficients.** Zhidkova, I.E. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 4p. (In Russian). Order Number DE90622142. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The program package for Krylov-Bogolyubov averaging method in high approximations applied to the system of two nonlinear second order differential equations with the periodic coefficients is described. The possibilities of programs, global algorithm, time and central processor memory estimations are done for equations which have the periodic coefficients before its linear part. 5 refs.

25234 (JINR-R–11-88-744) **Algorithms and programs for solution of Sturm-Liouville problem using the high order accuracy finite element method scheme.** Abrashkevich, A.G. (Uzhgorodskij Gosudarstvennyj Univ., Uzhgorod (Ukrainian SSR)); Kaschiev, M.S.; Puzynin, I.V. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 20p. (In Russian). Order Number DE90622143. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Some properties and peculiarities of high order accuracy approximations of finite element method for Sturm-Liouville problem have been investigated on the basis of numerical experiments for broad set of tests. The region of applicability of such approximations depending from a way setting of equation coefficients and need smoothness of solutions have been established. The use of high order schemes allowing to increase the effectiveness of solution of problems under consideration with simultaneous increase of calculation accuracy is shown. A description of program package intended for solving the Sturm-Liouville problem of high order finite element method is given. 19 refs.; 4 tabs.

25235 (K/DSRD–276) **Army War College final prototype optical disk system testing and evaluation report.** Klein, A.J.; Gillespie, S.J. Oak Ridge Gaseous Diffusion Plant, TN (USA). Mar 1990. 59p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OT21400. Order Number DE90008852. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report documents the continuation of the PC-based optical disk retrieval-storage system testing and evaluation activities that Data Systems Research and Development (DSRD) staff have performed over the last year for the Army War College (AWC), Carlisle, Pennsylvania. A previous report (see Army War College Optical Disk System Test and Evaluation Report, K/DSRD-74, April 1989) detailed the performance testing results of the initial two prototype optical disk systems evaluated by DSRD. Based on the results of this prototype system testing and evaluation, the AWC selected the SAIC/LaserData system for further development and testing. This report describes the development activities that were performed to enhance the SAIC/LaserData system for further development and testing. This report describes the development activities that were performed to enhance the SAIC/LaserData system and details the tests and evaluations that were performed under an environment similar to that which would be encountered at the sponsor's site. The prototype optical disk system that was tested and evaluated consists of two stations: a master scanning station for scanning, indexing, and storing of documents onto master and distribution disks and retrieval station for retrieving and displaying information contained on the distribution disks. The master scanning station includes a 386 Central Processing Unit (CPU), a high-speed scanner, and a dual 5.25-inch optical disk drive and is capable of being networked. The retrieval station, intended mainly for viewing documents, does not have a scanner and has only one optical disk drive.

25236 (LA–11543-C, pp. 87-101) **Software quality assurance for metal forming software - validation, verification, and testing.** Aramayo, G.A. (Oak Ridge National Lab., TN (USA)); Stoddart, W.C. Los Alamos National Lab., NM (USA). May 1989. (CONF-880259–Summ.: Metal forming modeling (MFM) subgroup of IMOG, Los Alamos, NM (USA), 23-25 Feb 1988). In *Minutes of the meeting, Metal Forming Modeling Subgroup of IMOG, February 1988.* Order Number DE89011401. Available from NTIS, PC A14/MF A01.

An outline of the original presentation is given in a series of slides. These present listings of the following: components of the software quality assurance procedure; software categories; software life cycle phases; requirements for the configuration control facility; validation and verification at the configuration control phase; components of the testing program; expected program behavior; and test data generation.

25237 (LA–11543-C, pp. 187-195) **Survey report and implementation options for engineering analysis software (EAS) usage in the NWC [Nuclear Weapons Complex].** Haberstroh, R.C. Los Alamos National Lab., NM (USA). May 1989. (CONF-880259–Summ.: Metal forming modeling (MFM) subgroup of IMOG, Los Alamos, NM (USA), 23-25 Feb 1988). In *Minutes of the meeting, Metal Forming Modeling Subgroup of IMOG, February 1988.* Order Number DE89011401. Available from NTIS, PC A14/MF A01.

A survey of Engineering Analysis Software (EAS), with application to production processes at the production facilities, was conducted in the Spring of 1987. The survey performed for DOE-AL, Production Operations Division, involved seven production facilities (GEND, Kansas City, Mound, Oak Ridge, Pantex, Rocky Flats, and Savannah River), and four design agencies (LANL, LLNL, SNLA, SNLL). The production facility survey had several key objectives, including identification of: EAS in use; EAS applications; EAS environment (hardware/software); and, desired EAS capabilities and enhancements. The survey of the design agencies also had several objectives, including identification of design agency EAS which could be used by the production facilities, and identifying ongoing design agency EAS development which could provide additional capabilities to the production facilities. The survey report was issued in August, 1987. A follow-up report, to be issued in March, 1988, will provide implementation options based on the survey results. For purposes of the survey, the scope of the EAS included software used in the design and analysis of production lines, components, production equipment and site buildings. Data analysis, production flow simulation and structure performance/integrity simulation software were included in addition to the pre/postprocessors supporting these software. All solution techniques(such as expert systems, finite element method, finite difference method and theory based) were also included. This presentation provides an overview of the information provided in both these reports.

25238 (LA–11543-C, pp. 261) **A knowledge system for automatic finite element mesh generation: AMEKS.** Mitchiner, J.L. (Sandia National Lab. Albuquerque, NM (USA)); Phillips, L.R.; Lin, Y.T.; Blacker, T.D. Los Alamos National Lab., NM (USA). May 1989. (CONF-880259–Summ.: Metal forming modeling (MFM) subgroup of IMOG, Los Alamos, NM (USA), 23-25 Feb 1988). In *Minutes of the meeting, Metal Forming Modeling Subgroup of IMOG, February 1988.* Order Number DE89011401. Available from NTIS, PC A14/MF A01.

The authors have developed a knowledge-based system, AMEKS, that automatically decomposes two-dimensional regions of multiple materials, with boundaries composed of straight and curved lines, into primitives appropriate for algorithmic generation of quadrilateral mesh for finite element analysis. Prior to AMEKS, this task required that a skilled analyst spend a few hours to a few days decomposing complex regions into primitive regions and preparing each primitive for algorithmic meshing, based on problem geometry and mesh requirements. AMEKS now performs these tasks automatically is now capable of automating mesh generation for a large percentage of the 2-D regions analysts mesh.

25239 (LA–11831-MS) **Los Alamos experiences with the IBM [International Business Machines] RISC SYSTEM/6000 workstations.** Simmons, M.L.; Wasserman, H.J. Los Alamos National Lab., NM (USA). Mar 1990. 22p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. Order Number DE90007918. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

RISC SYSTEM/6000 computers are workstations with a reduced instruction set processor recently developed by IBM. This report details the performance of the 6000-series computers as measured using a set of portable, standard-Fortran, computationally-intensive benchmark codes that represent the the scientific workload at the Los Alamos National Laboratory. The performance of the RISC SYSTEM/6000 machines is compared with corresponding data from a Sun-4/330, a Digital Equipment Corporation DECstation 3100, a single processor of a Convex C-240, a single-processor FPS-500, and a single processor of a CRAY Y-MP8/832. 22 refs., 11 tabs.

25240 (SAND–88-3291) **A time stepping algorithm for parallel computers.** Womble, D.E. Sandia National Labs., Albuquerque, NM (USA). Feb 1990. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE90008163. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Parabolic and hyperbolic differential equations are often solved numerically by time stepping algorithms. These algorithms have been regarded as sequential in time; that is, the solution on a time level must be known before the computation of the solution at subsequent time levels can start. While this remains true in principle, we demonstrate that it is possible for processors to perform useful work on many time levels simultaneously. Specifically, it is possible for processors assigned to "later" time levels to compute a very good initial guess for the solution based on partial solutions from previous time levels, thus reducing the time required for solution. The reduction in the solution time can be measured as parallel speed up. We demonstrate this algorithm for both linear and nonlinear problems. In addition, we discuss the convergence properties of the method based on the convergence properties of the underlying iterative method, and we present an accurate performance model from which the speedup and other quantities can be estimated. 9 refs., 3 figs., 3 tabs.

25241 (SAND–89-2097C) **Suboptimal strong stabilization using fixed-order dynamic compensation.** Jacobus, M. (Sandia

National Labs., Albuquerque, NM (USA)); Jamshidi, M.; Abdallah, C.; Dorato, P.; Bernstein, D. Sandia National Labs., Albuquerque, NM (USA). [1990]. 3p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9005135–1: 1990 American control conference, San Diego, CA (USA), 23-25 May 1990). Order Number DE90007455. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper considers the problem of stabilizing a plant using a suboptimal stable compensator of fixed order. The resulting equations are a modified form of the optimal projection equations, with the separation principle not holding in either the full- or reduced-order case. 6 refs.

25242 (SAND–89-2781) **A model and implementation of multigrid for massively parallel computers.** Womble, D.E. (Sandia National Labs., Albuquerque, NM (USA)); Young, B.C. Sandia National Labs., Albuquerque, NM (USA). Feb 1990. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE90008165. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Multigrid is a fast and popular iterative method used to solve linear partial differential equations. However, because the solution of very small problems is inherent in the multigrid iteration, it is difficult to implement efficiently on a massively parallel computer. In this paper, we present a model for the efficiency of multigrid on a parallel computer that depends only on the efficiency of the smoother at each level. This model can be used to verify that it is indeed difficult to obtain extremely high efficiencies (>95%), but that it is relatively easy to obtain moderately high efficiencies (70% to 85%). The model also indicates that moderately high efficiencies can still be achieved as the number of dimensions in the partial differential equation increases. We also present an implementation of the multigrid v-cycle that has achieved 84% efficiency on the 1,024 processor NCUBE/ten. 19 refs., 3 figs., 4 tabs.

25243 (SAND–90-0373C) **Developing a computer security training program.** Sandia National Labs., Albuquerque, NM (USA). [1990]. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9005106–2: 13. annual conference of the Computer Security Group, Augusta, GA (USA), 8-10 May 1990). Order Number DE90008499. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We all know that training can empower the computer protection program. However, pushing computer security information outside the computer security organization into the rest of the company is often labeled as an easy project or a dungeon full of dragons. Used in part or whole, the strategy offered in this paper may help the developer of a computer security training program ward off dragons and create products and services. The strategy includes GOALS (what the result of training will be), POINTERS (tips to ensure survival), and STEPS (products and services as a means to accomplish the goals).

25244 (SLAC-PUB–5184) **Scalable coherent interface.** Alnaes, K. (Dolphin Server Technology A.S., Oslo (Norway)); Kristiansen, E.H.; Gustavson, D.B.; James, D.V. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jan 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-9005132–1: CompEuro '90 conference, Tel Aviv (Israel), 7-9 May 1990). Order Number DE90008011. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The Scalable Coherent Interface (IEEE P1596) is establishing an interface standard for very high performance multiprocessors, supporting a cache-coherent-memory model scalable to systems with up to 64K nodes. This Scalable Coherent Interface (SCI) will supply a peak bandwidth per node of 1 GigaByte/second. The SCI standard should facilitate assembly of processor, memory, I/O and bus bridge cards from multiple vendors into massively parallel systems with throughput far above what is possible today. The SCI standard encompasses two levels of interface, a physical level and a logical level. The physical level specifies electrical, mechanical and thermal characteristics of connectors and cards that meet the standard. The logical level describes the address space, data transfer protocols, cache coherence mechanisms, synchronization primitives and error recovery. In this paper we address logical level issues such as packet formats, packet transmission, transaction handshake, flow control, and cache coherence. 11 refs., 10 figs.

25245 (UCID–21964) **Differential-algebraic equations as stiff ordinary differential equations.** Knorrenschild, M. Lawrence Livermore National Lab., CA (USA). May 1989. 23p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (ISCR–1989-01). Order Number DE90007922. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In this paper we show that differential-algebraic systems of index-1 can always be viewed as reduced problems from singular perturbed ODEs. Applying implicit Runge-Kutta methods to the singular perturbed system, we gain new insight into the relationship of order-reduction phenomena observed for stiff ODEs to that for differential-algebraic equations. We show that the order of convergence achieved for index-1-differential/algebraic equations is at least the order of B-convergence. 16 refs.

25246 (UCRL–21273) **Pixar data visualization tools overview: Final report.** Miller, M.C. Lawrence Livermore National Lab., CA (USA). Feb 1990. 23p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008525. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This article explains how to perform basic visualization operations on the Pixar. The three main operations performed on the Pixar are interactive planometric rendering, video film loop production, volumetric rendering and some simple image processing. All these and other high-level visualization operations use a common data format for storing sets of images known as the Pixar Volume which is created using Makevol. A number of other low-level tools facilitating visualization operations are also introduced and summarized. 10 refs., 2 figs.

25247 (UCRL–97646) **Cache coherency on the S-1 AAP.** Bruner, J.D.; Hagensen, G.W.; Jensen, E.H.; Pattin, J.C.; Broughton, J.M. Lawrence Livermore National Lab., CA (USA). 11 Nov 1987. 10p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CONF-880540–3: 15. annual international symposium on computer architecture, No City Given, HI (USA), 30 May - 2 jun 1988). Order Number DE90008684. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A cache coherency scheme for shared-memory multiprocessors is described. Unlike most cache coherency schemes, the proposed method does not require the client caches to be connected by a shared bus. Participating caches need only expend cycles to process cache blocks which are shared — there is no performance penalty for caches which do not contain shared data. The S-1 AAP, a multiprocessor under construction at Lawrence Livermore National Laboratory, uses this scheme. 12 refs., 12 figs.

25248 (UCRL–97650) **Ring interconnection network for the S-1 AAP multiprocessor.** Moldenahuer, V.Y.; Farmwald, P.M.; Pattin, J.C.; Broughton, J.M. Lawrence Livermore National Lab., CA (USA). 12 Nov 1987. 13p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CONF-880540–2: 15. annual international symposium on computer architecture, No City Given, HI (USA), 30 May - 2 jun 1988). Order Number DE90008685. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper presents an interconnection network for the S-1 AAP, a large-scale multiprocessor being constructed at Lawrence Livermore National Laboratory. The packet-switched interconnect consists of dual counter-rotating rings, with nodes modelled as non-uniform crossbars. The advantages of this interconnect are its conceptual simplicity, its suitability for high-speed implementation, and its extensibility. The ability to queue messages in the interconnect provides reliable transmission without acknowledgments or flow control. The motivations behind the design are discussed, and the ring organization is described. Both difficult design issues and benefits of the design are discussed. 6 refs., 12 figs.

25249 (UCRL–101573) **Simulating speckle interferometry.** Johansson, E.M.; Lawrence, T.W.; Fitch, J.P.; Sherwood, R.J. Lawrence Livermore National Lab., CA (USA). Feb 1990. 12p.

Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900285–3: SPIE astronomical telescopes and instrumentation for the 21st century symposium, Tucson, AZ (USA), 11-17 Feb 1990). Order Number DE90007848. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper describes a simulator we have developed to model speckle imaging and reconstruction of astronomical objects. The simulator was designed as a tool in the development of new signal and image processing techniques of our high resolution imaging research. It has been found to accurately replicate the speckle imaging process, and can be used to predict experimental results under various environmental conditions. The simulator is described in detail, including the modeling of atmospheric turbulence effects, the generation speckle images, and the simulation of the telescope and image detection processes. 13 refs., 5 figs.

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Refer also to citation(s) 23458, 23627, 23628, 23829, 23832, 23843, 24186, 24334, 25225, 25243

25250 (CONF-9003104–1) **Incorporating GISs [geographic information systems] into decision support systems: Where have we come from and where do we need to go?.** Honea, R.B.; Hake, K.A.; Durfee, R.C. Oak Ridge National Lab., TN (USA). [1990]. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From GIS '90 conference; Vancouver (UK); 12-16 Mar 1990. Order Number DE90008749. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper reviews some of the pitfalls in the design and use of GISs that were encountered with both large and small projects for a variety of sponsors. The stand-alone, self-sufficient GIS world prevalent today does not adequately meet the needs of decision support systems. Developers of these systems are left with the difficult task of software system integration which generally produces less than adequate results. Modularization of GIS concepts is critical to the solution which involves the establishment of a GIS toolkit. More functionality and flexibility are introduced through this approach so that GIS may be truly "applied" in system development projects.

25251 (LBL–25746) **Specifications for Version 1.0 of the Army Data Encyclopedia.** Gey, F.; Holmes, H. Lawrence Berkeley Lab., CA (USA). 30 Sep 1988. 22p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90008711. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This document provides a more detailed description of the Army Data Encyclopedia (ADE) Version 1.0, in accordance with the Data Encyclopedia Architecture for Army Information Management. The software and contents of the ADE are key mechanisms that are necessary to achieve interoperability, integration and synchronization of Army information systems. The ADE architecture is intended to provide a global view, long-term direction, and the conceptual foundation for further development. In accord with the architecture, the ADE will develop through a sequence of increasingly powerful versions, supporting a series of Army-wide Information Mission Area (IMA) efforts, such as data element standardization. The major components of the ADE Version 1.0 are an ANSI-FIPS Standard Information Resource Dictionary System (IRDS) framework, which is implemented using a relational DBMS, a user interface for schema and data maintenance, a user interface for the Data Element search/retrieval/approval process, and the loading of the actual data of the ADE. This paper assumes the reader is familiar with the Data Encyclopedia Architecture document. It provides background for ADE Version 1.0 and a brief status report of ADE related activities in progress. It outlines a software structure for the ADE, functionality to be implemented within the ADE 1.0, structure of the data element approval process and user interface, initial data content of the ADE, documentation needs of the ADE, and remote user access strategies for the ADE. 5 refs., 9 figs.

25252 (PNL-SA–17266) **Computer assisted retrieval: Two applications.** Berndt, V.L. Pacific Northwest Lab., Richland, WA (USA). Feb 1990. 11p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. (CONF-9003107–1: ARMA Region X association of records managers and administrators conference, Boise, ID (USA), 7-9 Mar 1990). Order Number DE90008604. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report overviews the computer assisted retrieval (CAR) system used at Pacific Northwest Laboratory to streamline the Radiological Records Group's record–keeping practices. (JF)

25253 (SAND–89-2783C) **A paradoxical result in unconditionally secure authentication codes - and an explanation.** Simmons, G.J. (Sandia National Labs., Albuquerque, NM (USA)); Smeets, B. Sandia National Labs., Albuquerque, NM (USA). [1989]. 29p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-891282–1: IMA conference on cryptography and coding, Cirencester (UK), 18-20 Dec 1989). Order Number DE90008529. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Simmons defined an authentication code to be perfect if all of the information involved in the secret key exchange between the transmitter and receiver is used to either provide perfect secrecy (in the sense of Shannon) for the information being communicated or else to confound the opponent; i.e., to detect and prevent deception of the receiver. Numerous unconditionally secure and perfect authentication codes have been devised by Brickell, Simmons, Stinson and others that use the k bits of equivocation (uncertainty) to an opponent about the authentication key to provide perfect secrecy for a q bit source, $q < k$, i.e., an opponent who knows the encoding scheme but not the encoding rule upon observing the encoding of a source state, cannot do better at identifying that state than to randomly guess at it using the a priori probability distribution on the source states–and to provide 2^{-k+q} security against the first round of impersonation and substitution attacks. Intuitively, this would appear to have "used up" the k bits of equivocation about the key. The "paradox" referred to in the title is that this isn't true and that some security against deception may still be achievable for successive rounds of communication and authentication. In this paper, we will discuss this apparent paradox and show how its explanation forces a reexamination of the basic authentication channel bounds. 17 refs., 5 figs., 8 tabs.

25254 (SAND–90-0237) **An evaluation and description of a commercially-available integrated two-door entry control portal.** Kefauver, H.L. Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 74p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC04-76DP00789. Order Number DE90007900. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Integrated access control portals (booths) are fast becoming a familiar part of medium-to-high security systems. Facilities wishing to expand their operations or to tighten their security, while at the same time limit or reduce their security operating expenses, find the application of portals to be a cost-effective alternative to manned entry points. With the advent of microprocessors and commuter control, portals may now be designed to operate in an automated (and in some cases, stand-alone) mode, requiring human intervention only in the event of an alarm condition. Because human intervention is minimized, a single guard can monitor the operation of several portals and thereby control multiple entry points. This report presents a description of a typical portal and its functioning and provides the information necessary to formulate a set of portal requirements. 8 figs.

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AC01-86ER60446	**Walcoff and Associates, Inc., Alexandria, VA (USA)**	
	15:24354	DOE/ER/60446–T1
AC01-87CE40762	**RCG/Hagler, Bailly, Inc., Washington, DC (USA)**	
	15:23875	DOE/CE/40762–T2
AC01-88NE32135	**NUS Corp., Gaithersburg, MD (USA)**	
	15:23792	NUS–5125
AC02-76CH00016	**Brookhaven National Lab., Upton, NY (USA)**	
	15:23562	BNL–43887
	15:23563	BNL-NUREG–43926
	15:23564	BNL-NUREG–43927
	15:23720	BNL–41973
	15:23721	BNL–42102
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	15:23771	BNL–43929
	15:23772	BNL-NUREG–43152
	15:23773	BNL-NUREG–43173
	15:23774	BNL-NUREG–43960
	15:23887	BNL–43844
	15:23983	BNL–43937
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	15:24349	BNL–52227
	15:24350	BNL–52231
	15:24788	BNL–43663
	15:24987	BNL-NCS–51771-Ed.1-Suppl.5
	Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research	
	15:23785	NUREG/CP–0110
	Brookhaven National Lab., Upton, NY (USA). National Synchrotron Light Source Dept.	
	15:24256	BNL–43886
	Nuclear Regulatory Commission, Washington, DC (USA). Div. of Radiation Protection and Emergency Preparedness	
	15:23791	NUREG/CR–5527
	15:23615	CONF-8904178–
	15:24001	CONF-890197–
	15:24221	CONF-890197–
	15:24222	CONF-890197–
	15:24246	CONF-890197–
	15:23944	Published article
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	15:23950	Published article
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	15:23979	Published article
	15:24021	Published article
	15:24082	Published article
	15:24905	Published article
	15:25007	Published article
	15:25015	Published article
	15:25063	Published article
AC02-76CH03000	**Fermi National Accelerator Lab., Batavia, IL (USA)**	
	15:23985	FNAL-TM–1587
	15:24212	FNAL/C–90/29-T
	15:24213	FNAL-TM–1615
	15:24237	FNAL/C–90/40
	15:24238	FNAL-TM–1646
	15:24258	FNAL-TM–1621
	15:24259	FNAL-TM–1641
	15:24893	FNAL-TM–1636
AC02-76CH03073	**Princeton Univ., NJ (USA). Plasma Physics Lab.**	
	15:25150	PPPL–2676
	15:25151	PPPL–2679
	15:25194	PPPL-Q–46
	15:25173	Published article
	15:24945	Published article
AC02-76ER01195	**Illinois Univ., Urbana, IL (USA). Dept. of Physics**	
	15:24902	UIUC-HEPG–90-42
	15:24903	UIUC-HEPG–90-44
	15:24932	UIUC-HEPG–90-36
	15:24933	UIUC-HEPG–90-40
	15:23951	Published article
	15:24071	Published article
	15:25003	Published article
	15:24905	Published article
	15:24855	Published article
	15:24980	Published article
	15:25173	Published article
	15:23996	Published article
AC02-78ER04915	**Washington Univ., St. Louis, MO (USA). Dept. of Physics**	
	15:24966	DOE/ER/04915–4
	15:25177	Published article
AC02-83CH10093	**Massachusetts Inst. of Tech., Cambridge, MA (USA)**	
	15:23673	SERI/TR–253-3549
	Solar Energy Research Inst., Golden, CO (USA)	
	15:23640	DOE/CH/10093–68
	15:23652	SERI/SP–220-3548
	15:23670	SERI/TP–211-3666
	15:23693	DOE/CH/10093–64
	15:23709	SERI/TP–257-3603
	15:23900	Published article
	15:24002	Published article
	15:25079	Published article
AC02-83ER13086	**Wisconsin Univ., Madison, WI (USA)**	
	15:24703	DOE/ER/13086–T3
AC02-85NE37944	**Massachusetts Inst. of Tech., Cambridge, MA (USA)**	
	15:23739	DOE/NE/37944–1

Contract No.	Abstract No.	Report No.
AC02-87ER40350	**California Univ., Los Angeles, CA (USA). Dept. of Physics**	
	15:24257	DOE/ER/40350–3
AC03-76SF00098	**Stanford Linear Accelerator Center, Menlo Park, CA (USA)**	
	15:24233	ABC–1
	15:24234	ABC–2
	Lawrence Berkeley Lab., CA (USA)	
	15:23800	LBL–27964
	15:23801	LBL–28083
	15:23861	LBL–25430
	15:23889	LBL–27872
	15:24055	LBL–28104
	15:24217	LBL–28319
	15:24245	LBL–28222
	15:24716	LBL–28248
	15:24930	LBL–28556
	15:25056	LBL–28172
	15:25251	LBL–25746
	15:24225	CONF-890197–
	15:24254	CONF-890197–
	15:23949	Published article
	15:23968	Published article
	15:23980	Published article
	15:23994	Published article
	15:24018	Published article
	15:24056	Published article
	15:24058	Published article
	15:24073	Published article
	15:24075	Published article
	15:24085	Published article
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	15:24107	Published article
	15:24194	Published article
	15:24324	Published article
	15:24949	Published article
	15:25016	Published article
	15:25017	Published article
	15:25026	Published article
	15:25027	Published article
	15:25205	Published article
AC03-76SF00515	**Stanford Linear Accelerator Center, Menlo Park, CA (USA)**	
	15:24233	ABC–1
	15:24234	ABC–2
	15:24277	PEP-NOTE–381
	15:25244	SLAC-PUB–5184
	15:24255	Published article
	15:24009	Published article
AC03-85SF15935	**Science Applications International Corp., McLean, VA (USA). Plasma Physics Div.**	
	15:25121	DOE/SF/15935–T1
AC03-86SF16496	**New Mexico State Univ., Las Cruces, NM (USA). Arts and Sciences Research Center**	
	15:24842	DOE/SF/16496–T1
	15:25181	Published article
	15:24254	CONF-890197–
AC04-76DP00613	**Allied-Signal Aerospace Co., Kansas City, MO (USA). Kansas City Div.**	
	15:24041	KCP–613-4202
AC04-76DP00789	**Sandia National Labs., Albuquerque, NM (USA)**	
	15:23601	SAND–88-1387
	15:23603	SAND–89-2176C
	15:23604	SAND–89-2378C
	15:23627	SAND–89-2600
	15:23628	SAND–89-2690
	15:23666	SAND–90-0438C
	15:23989	SAND–90-0648C
	15:23990	SAND–90-0653C
	15:24145	SAND–88-0714
	15:24148	SAND–89-0412C
	15:24186	SAND–86-1397
	15:24315	SAND–0494C
	15:24331	SAND–89-2580C
	15:24334	SAND–87-1734
	15:24335	SAND–90-0751C
	15:24344	SAND–89-2534
	15:25240	SAND–88-3291
	15:25241	SAND–89-2097C
	15:25242	SAND–89-2781
	15:25243	SAND–90-0373C
	15:25253	SAND–89-2783C
	15:25254	SAND–90-0237
	15:23625	SAND–89-0926/1
	15:23626	SAND–89-0926/2
	15:23629	SAND–90-0859C
	15:23672	SAND–89-7028
	15:23675	SAND–89-7040
	Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research	
	15:23786	NUREG/CR–4668
	15:23787	NUREG/CR–4691-Vol.2
	15:23788	NUREG/CR–4691-Vol.3
	15:23976	Published article
	15:23995	Published article
	15:24020	Published article
	15:24089	Published article
	15:24200	Published article
	15:24203	Published article
	15:24205	Published article
AC04-88DP43495	**EG and G Mound Applied Technologies, Miamisburg, OH (USA)**	
	15:24329	MLM–3627
	15:24330	MLM–3629
AC04-90DP62349	**EG and G Rocky Flats, Inc., Golden, CO (USA)**	
	15:24381	RFP–4409
	15:24012	Published article
AC05-84OR21400	**Oak Ridge National Lab., TN (USA)**	
	15:23567	CONF-900406–45
	15:23568	CONF-900406–46
	15:23576	CONF-8911175–1
	15:23588	ORNL/TM–11332
	15:23743	CONF-900343–6
	15:23776	CONF-900382–1
	15:23777	CONF-9002100–1
	15:23778	CONF-9005135–2
	15:23844	ORNL/FTR–3543
	15:23857	CONF-891173–
	15:23888	CONF-900496–1
	15:23915	CONF-900364–2
	15:23916	CONF-9003111–1-Vugraphs
	15:23937	ORNL/FTR–3566
	15:23964	ORNL/FTR–3572
	15:23984	CONF-900364–1
	15:24142	CONF-900559–13
	15:24275	ORNL/FTR–3546
	15:24276	ORNL/FTR–3564
	15:24309	ORNL/FTR–3551
	15:24314	CONF-900451–1
	15:24343	ORNL/OMIS–90/3
	15:24351	CONF-900255–1
	15:24366	ORNL/TM–11457
	15:24393	ORNL/RASA–88/59
	15:24394	ORNL/TM–11182
	15:24433	CONF-891098–6
	15:24717	ORNL/FTR–3548
	15:25067	CONF-8909210–9
	15:25068	CONF-8909210–10

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	15:25120	DOE/OR/21400–T417
	15:25192	ORNL/FTR–3557
	15:25226	CONF-891273–3
	15:25227	CONF-900451–2
	15:25228	CONF-900599–4
	15:25250	CONF-9003104–1
	15:23620	CONF-8709104–
	Oak Ridge National Lab., TN (USA). Fusion Engineering Design Center	
	15:25148	ORNL/FEDC–89/1
	Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering	
	15:23752	NUREG/CR–5511
	15:23790	NUREG/CR–5404-Vol.1
	15:24411	CONF-8904177–
	15:23537	Published article
	15:23998	Published article
	15:24012	Published article
	15:24086	Published article
	15:24707	Published article
	15:24781	Published article
	15:24860	Published article
	15:24865	Published article
	15:24870	Published article
	15:25024	Published article
	15:25025	Published article
	15:25170	Published article
AC05-84OS21400	**Oak Ridge Y-12 Plant, TN (USA)**	
	15:23614	Y/TS–83-Rev.5
AC05-84OT21400	**Oak Ridge Gaseous Diffusion Plant, TN (USA)**	
	15:23859	DOE/HWP–96
	15:23987	K/ETO–21
	15:24102	K/CSD/INF–88/23
	15:24103	K/CSD/TM–85
	15:25235	K/DSRD–276
AC05-86OR21600	**Westinghouse Materials Co. of Ohio, Cincinnati, OH (USA). Feed Materials Production Center**	
	15:24036	DOE/OR/21600–T35
AC06-76RL01830	**Battelle-Northwest, Richland, WA (USA). Pacific Northwest Lab.**	
	15:23565	BNWL-CC–2142
	Washington Univ., Seattle, WA (USA). School of Fisheries	
	15:23665	DOE/BP/35885–2
	Pacific Northwest Lab., Richland, WA (USA)	
	15:23541	PNL-SA–17727
	15:23589	PNL–7142
	15:23590	PNL–7273
	15:23591	PNL–7280
	15:23592	PNL-SA–17157
	15:23593	PNL-SA–17194
	15:23594	PNL-SA–17242
	15:23595	PNL-SA–17284
	15:23596	PNL-SA–17285
	15:23597	PNL-SA–17319
	15:23598	PNL-SA–17633
	15:23599	PNL-SA–17690
	15:23617	BNWL-CC–1992
	15:23618	PNL-SA–17283
	15:23623	PNL-SA–17282
	15:23624	PNL-SA–17336
	15:23793	PNL-SA–17794
	15:23797	PNL-SA–17339
	15:23833	PNL-SA–17399
	15:23868	PNL-SA–17851
	15:23965	PNL-SA–17226
	15:23966	PNL-SA–17271
	15:23967	PNL-SA–17450
	15:24380	PNL-SA–16909
	15:24428	BNWL-CC–1386
	15:24429	BNWL-CC–1411
	15:24430	BNWL-CC–1436
	15:24431	BNWL-CC–2253
	15:24432	BNWL-CC–2403
	15:24700	PNL-SA–17289
	15:24736	PNL-SA–17037
	15:25193	PNL-SA–16981
	15:25252	PNL-SA–17266
	15:23538	Published article
	15:24024	Published article
	15:24877	Published article
AC06-87RL10930	**Westinghouse Hanford Co., Richland, WA (USA)**	
	15:23607	WHC-EP–0182-20
	15:23608	WHC-EP–0182-21
	15:23609	WHC-EP–0182-22
	15:23610	WHC-EP–0258
	15:23611	WHC-EP–0321
	15:23612	WHC-SA–0217
	15:23613	WHC-SA–0711
	15:23794	WHC-SA–0865
AC07-76ID01570	**Little (Arthur D.), Inc., Cambridge, MA (USA)**	
	15:23919	EGG-M–88425
	California Univ., Berkeley, CA (USA). Dept. of Materials Science and Engineering	
	15:23920	EGG-M–89453
	EG and G Idaho, Inc., Idaho Falls, ID (USA)	
	15:23779	EGG-M–89191
	15:23877	EGG-M–89483
	National Food Processors Association, Dublin, CA (USA)	
	15:23876	DOE/ID–10269
	15:25080	Published article
AC07-82ID12356	**Acres International Corp., Amherst, NY (USA)**	
	15:23657	DOE/ID/12356–T1
AC08-87NV10576	**Science Applications International Corp., Las Vegas, NV (USA)**	
	15:23566	CONF-900406–44
	15:23569	CONF-900406–47
	15:23570	CONF-900406–48
	15:23571	CONF-900406–49
	15:23572	CONF-900406–50
	15:23573	CONF-900406–51
	15:23574	CONF-900406–52
	15:23575	CONF-900406–53
	15:23577	DOE/NV/10576–19
	15:23578	DOE/NV/10576–21
	15:24413	CONF-8904178–
AC21-85MC21353	**EG and G Washington Analytical Services Center, Inc., Morgantown, WV (USA)**	
	15:23267	DOE/MC/21353–2793
AC21-86MC21023	**Foster Wheeler Energy Corp., Livingston, NJ (USA)**	
	15:23711	DOE/MC/21023–2760
	Foster Wheeler Development Corp., Livingston, NJ (USA)	
	15:23710	DOE/MC/21023–2758-Vol.2
	15:23653	Published article
AC22-86PC91021	**Florida State Univ., Tallahassee, FL (USA). Dept. of Physics**	
	15:23362	CONF-860903–5
	15:23716	CONF-870810–2
AC22-88PC88814	**Advanced Fuel Research, Inc., East Hartford, CT (USA)**	
	15:23348	DOE/PC/88814–T4

Contract No.	Abstract No.	Report No.
AC22-88PC88818	Hydrocarbon Research, Inc., Lawrenceville, NJ (USA)	
	15:23349	DOE/PC/88818–4
AC22-89PC89805	Little (Arthur D.), Inc., Cambridge, MA (USA)	
	15:23372	DOE/PC/89805–T1
AI01-86ER40282	National Inst. of Standards and Technology (NML), Gaithersburg, MD (USA). Electricity Div.	
	15:25092	DOE/ER/40282–T1
AI05-83ER13108	National Inst. of Standards and Technology, Gaithersburg, MD (USA). Chemical Kinetics Div.	
	15:24048	DOE/ER/13108–T5
AI05-84ER13150	National Inst. of Standards and Technology (NML), Gaithersburg, MD (USA). Center for Atomic, Molecular and Optical Physics	
	15:24049	DOE/ER/13150–T3
AI79-87BP35885	Washington Univ., Seattle, WA (USA). School of Fisheries	
	15:23665	DOE/BP/35885–2
	15:24083	Published article
	15:24019	Published article
FC03-85DP40200	Rochester Univ., NY (USA). Lab. for Laser Energetics	
	15:25186	DOE/DP/40200–81
	15:25187	DOE/DP/40200–110
	15:25188	DOE/DP/40200–120
FC07-89ID12917	EG and G Idaho, Inc., Idaho Falls, ID (USA)	
	15:23877	EGG-M–89483
FC21-86MC11076	Western Research Inst., Laramie, WY (USA)	
	15:23533	DOE/MC/11076–2757
	15:23534	DOE/MC/11076–2762
	15:23535	DOE/MC/11076–2765
	15:23531	DOE/MC/11076–2767
FG01-87IE10574	Arkansas Research Consultants, Inc., Fayetteville, AR (USA)	
	15:23681	DOE/IE/10574–T2
	15:23682	DOE/IE/10574–T3
	15:23683	DOE/IE/10574–T3-Exec.Summ.
FG02-84ER13227	Utah Univ., Salt Lake City, UT (USA)	
	15:25069	DOE/ER/13227–6
FG02-84ER13244	Massachusetts Inst. of Tech., Cambridge, MA (USA). Francis Bitter National Magnet Lab.	
	15:23259	DOE/ER/13244–1
FG02-84ER13282	Massachusetts Inst. of Tech., Cambridge, MA (USA). Dept. of Chemical Engineering	
	15:24131	DOE/ER/13282–7
	15:23901	Published article
FG02-85ER13333	Massachusetts Univ., Amherst, MA (USA). Dept. of Chemical Engineering	
	15:24146	DOE/ER/13333–6
FG02-85ER13405	State Univ. of New York, Buffalo, NY (USA). Dept. of Electrical and Computer Engineering	
	15:24839	DOE/ER/13405–T3
FG02-85ER13421	Joint Inst. for Lab. Astrophysics, Boulder, CO (USA)	
	15:24840	DOE/ER/13421–T1
	15:23972	Published article
	15:23973	Published article
	15:24135	Published article
	15:24136	Published article
	15:24138	Published article
	15:24879	Published article
FG02-85ER53205	Connecticut Univ., Storrs, CT (USA)	
	15:25117	DOE/ER/53205–4
	15:24862	Published article
FG02-86ER13466	Woods Hole Oceanographic Institution, MA (USA). Dept. of Chemistry	
	15:24789	DOE/ER/13466–T1
	15:23461	Published article
	15:23685	Published article
FG02-86ER13486	Brandeis Univ., Waltham, MA (USA)	
	15:24704	DOE/ER/13486–T1
FG02-86ER13489	Rensselaer Polytechnic Inst., Troy, NY (USA)	
	15:24147	DOE/ER/13489–4
FG02-86ER13549	Pennsylvania State Univ., University Park, PA (USA). Dept. of Physics	
	15:24841	DOE/ER/13549–4
	15:24023	Published article
FG02-86ER13603	Boston Univ., MA (USA). Dept. of Chemistry	
	15:24051	DOE/ER/13603–T3
	15:24884	Published article
	15:24886	Published article
FG02-86ER40291	State Univ. of New York, Binghamton, NY (USA). Dept. of Physics	
	15:24895	DOE/ER/40291–6
FG02-86ER45269	Lehigh Univ., Bethlehem, PA (USA)	
	15:23917	DOE/ER/45269–T1
FG02-86ER60394	Illinois Univ., Chicago, IL (USA)	
	15:24353	DOE/ER/60394–2
	15:24706	Published article
	15:24081	Published article
FG02-87ER13690	Pennsylvania State Univ., University Park, PA (USA)	
	15:23647	DOE/ER/13690–2
FG02-87ER13706	Wisconsin Univ., Madison, WI (USA)	
	15:23641	CONF-8708155–
	15:24092	Published article
	15:23974	Published article
FG02-87ER60612	Colorado State Univ., Fort Collins, CO (USA). Dept. of Range Science	
	15:24389	DOE/ER/60612–3
	15:24026	Published article
FG02-88ER13847	Rockefeller Univ., New York, NY (USA)	
	15:25070	DOE/ER/13847–1
FG02-88ER13935	Iowa Univ., Iowa City, IA (USA)	
	15:24052	DOE/ER/13935–1
FG02-88ER60697	Jackson Lab., Bar Harbor, ME (USA)	
	15:24705	DOE/ER/60697–T1
FG02-89ER40494	Superconducting Supercollider Lab., Dallas, TX (USA)	
	15:24211	CONF-890270–
FG02-89ER52159	Illinois Univ., Urbana, IL (USA)	
	15:25116	DOE/ER/52159–1
FG02-89ER53291	Wisconsin Univ., Madison, WI (USA). Plasma Physics Research	
	15:25119	DOE/ER/53291–150
FG02-89ER60773	Illinois Univ., Urbana, IL (USA). Dept. of Civil Engineering	
	15:23492	DOE/ER/60773–T1
	15:24434	DOE/ER/60773–1
FG02-89ER60784	Stockholm Univ. (Sweden). Dept. of Radiobiology	
	15:24749	DOE/ER/60784–1
FG02-89ER60809	Michigan State Univ., East Lansing, MI (USA). Dept. of Crop and Soil Sciences	
	15:24390	DOE/ER/60809–1
FG02-89ER60836	Utah Univ., Salt Lake City, UT (USA). Radiobiology Div.	
	15:24722	DOE/ER/60836–1
	15:24022	Published article
	15:24108	Published article

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FG03-88ER53275	**Wisconsin Univ., Madison, WI (USA). Plasma Physics Research**	
	15:25119	DOE/ER/53291–150
	15:25161	Published article
	15:24099	Published article
	15:24109	Published article
FG05-87ER40380	**Southeastern Universities Research Association, Newport News, VA (USA)**	
	15:24896	DOE/ER/40380–1
FG05-88ER53278	**Old Dominion Univ., Norfolk, VA (USA). Dept. of Electrical and Computer Engineering**	
	15:25118	DOE/ER/53278–2
FG07-83ID12467	**Little (Arthur D.), Inc., Cambridge, MA (USA)**	
	15:23919	EGG-M–88425
FG09-84ER13296	**South Carolina Univ., Columbia, SC (USA). Dept. of Chemistry**	
	15:24050	DOE/ER/13296–6
FG09-85ER60351	**Skidaway Inst. of Oceanography, Savannah, GA (USA)**	
	15:24790	DOE/ER/60351–5
FG09-86ER13543	**Georgia Univ., Athens, GA (USA). Research Foundation**	
	15:23646	DOE/ER/13543–4
FG09-86ER60450	**Skidaway Inst. of Oceanography, Savannah, GA (USA)**	
	15:24791	DOE/ER/60450–4
	15:24229	CONF-890197–
	15:24231	CONF-890197–
	15:24248	CONF-890197–
	15:24250	CONF-890197–
	15:23978	Published article
	15:24864	Published article
	15:24994	Published article
	15:24995	Published article
	15:25084	Published article
W-31109-ENG-38	**Argonne National Lab., IL (USA)**	
	15:23413	ANL/FE–89/7
	15:23756	CONF-900143–30
	15:23769	ANL–89/32
	15:23910	ANL/PPRNT–90-201
	15:23911	ANL/PPRNT–90-207
	15:23912	ANL/PPRNT–90-208
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	15:23958	ANL/PPRNT–90-204
	15:24029	ANL/PPRNT–90-206
	15:24045	ANL/PPRNT–90-200
	15:24235	ANL/PPRNT–90-205
	15:24702	ANL/PPRNT–90-202
	15:24721	CONF-8910367–1
	15:25225	ANL–89/43
	Argonne National Lab., IL (USA). Energy and Environmental Systems Div.	
	15:23454	ANL/EES-TM–305
	USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of Planning and Environment	
	15:23407	DOE/FE–61819-H1
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	15:23782	*See* IWGFPT–27			
CONF-8703333–		(Installation and maintenance of subsea production system; Haugesund (Norway); 16-18 Mar 1987)			
	15:24163	*See* NEI-NO–102			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-8704393–		(Technical meeting on energy conservation; Moscow (USSR); 13-17 Apr 1987)			
	15:23854	*See* AFME–Z-0096			
CONF-870810–		(8. international symposium on plasma chemistry; Tokyo (Japan); 31 Aug - 4 sep 1987)			
2	15:23716	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008821	MF-105
CONF-8708155–		(International symposium on plant transposable elements; Madison, WI (USA); 22-26 Aug 1987)			
	15:23641	Plenum Publishing Corporation, 233 Spring Street, New York, NY 10013			ND-408
CONF-8708356–		(International Energy Agency Task Leaders workshop; Ottawa (Canada); Aug 1987)			
	15:23895	*See* OU/ME–CE02910			
CONF-8709104–		(ANS/ORNL topical conference on population exposure from the nuclear fuel cycle; Oak Ridge, TN (USA); 14-18 Sep 1987)			
	15:23620	Gordon and Breach Science Publishers S.A., P.O. Box 161, 1820 Montreux 2, Switzerland			MF-500
CONF-870928–		(Seminar for Latin America on the application of isotope techniques in hydrology; Mexico City (Mexico); 28 Sep - 2 oct 1987)			
	15:24792	*See* IAEA-TECDOC–502			
CONF-8712160–		(1. EPRI fossil plant retrofits for improved heat rate and availability conference; San Diego, CA (USA); 1-3 Dec 1987)			
	15:23712	*See* EPRI-GS–6725			
CONF-8804321–		(Workshop on climate feedbacks and the role of peatlands, tundra, and boreal ecosystems in the global carbon cycle; Oak Ridge, TN (USA); 4-6 Apr 1988)			
Summ.	15:24366	*See* ORNL/TM–11457			
CONF-880521–		(10. symposium on biotechnology for fuels and chemicals; Gatlinburg, TN (USA); 16-20 May 1988)			
	15:23352				
	15:23353				
CONF-8805350–		(8. All-Union conference on the methods of preparation and analysis of high-purity substances; Gor'kij (USSR); 10 May 1988)			
	15:24010	*See* INIS-SU–147/A			
CONF-880540–		(15. annual international symposium on computer architecture; No City Given, HI (USA); 30 May - 2 jun 1988)			
2	15:25248	*See* UCRL–97650			
3	15:25247	*See* UCRL–97646			
CONF-880601–		(American Nuclear Society annual meeting; San Diego, CA (USA); 12-16 Jun 1988)			
55	15:23612	*See* WHC-SA–0217			
CONF-8806460–		(82. annual meeting of association of air pollution control and hazardous waste management; Anaheim, CA (USA); 25-30 Jun 1988)			
1	15:23721	*See* BNL–42102			
CONF-8806461–		(Workshop on site windspeed estimation; Norwich (UK); 29 Jun - 1 jul 1988)			
	15:23694	*See* ETSU-N–114			
CONF-880929–		(15. symposium on fusion technology (SOFT-15); Utrecht (Netherlands); 19-23 Sep 1988)			
	15:25183	*See* CEA-CONF–9874			
	15:25184	*See* CEA-CONF–9875			
	15:25185	*See* CEA-CONF–9876			
CONF-8809459–		(Conference on the systems analysis approach to environmental and natural resources management in the Baltic region; Gdansk (Poland); 26-29 Sep 1988)			
	15:23802	*See* NEI-DK–264			
CONF-8810105–		(8. annual EPRI conference on coal gasification; Palo Alto, CA (USA); 19-20 Oct 1988)			
	15:23360	*See* BG-MRS-E–564			

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CONF-881024–		(ANS topical meeting on the TMI-2 accident: materials behavior and plant recovery technology; Washington, DC (USA); 30 Oct - 4 nov 1988)			
	15:23775	*See* CEA-DAS–578			
CONF-8810312–		(AUTOTESTCON '88: IEEE international automatic testing conference; Minneapolis, MN (USA); 4-6 Oct 1988)			
1	15:23861	*See* LBL–25430			
CONF-8811174–		(Workshop on the management of radioactively contaminated soils; Knoxville, TN (USA); 10 Nov 1988)			
Summ.	15:23588	*See* ORNL/TM–11332			
CONF-8811199–		(Workshop on scintillating fiber detector development for the SSC; Batavia, IL (USA); 14-16 Nov 1988)			
4	15:23985	*See* FNAL-TM–1587			
CONF-890197–		(Workshop on advanced accelerator concepts; Lake Arrowhead, CA (USA); 9-13 Jan 1989)			
	15:24001				
	15:24201				
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CONF-890199–		(24. Rencontre de Moriond on tests of fundamental laws in physics; Les Arcs (France); 21-28 Jan 1989)			
	15:24305	*See* LAPP-EXP–89-03			
CONF-890201–		(118. AIME annual meeting; Las Vegas, NV (USA); 26 Feb 1989)			
2	15:23919	*See* EGG-M–88425			
CONF-890207–		(Waste management '89: 15th international waste management symposium conference; Tucson, AZ (USA); 26 Feb - 2 mar 1989)			
	15:24285	*See* CEA-CONF–9833			
CONF-8902142–		(Workshop on saving energy and reducing atmospheric pollution by controlling summer heat islands; Berkeley, CA (USA); 23-24 Feb 1989)			
	15:23889	*See* LBL–27872			
CONF-8902165–		(Smolt survival workshop; Friday Harbor, WA (USA); 1-3 Feb 1989)			
Summ.	15:23665	*See* DOE/BP/35885–2			
CONF-890270–		(International industrial symposium on the super collider; New Orleans, LA (USA); 8-10 Feb 1989)			
	15:24211	Plenum Publishing Corporation, 233 Spring Street, New York, NY 10013			ND-414
CONF-8903203–		(Meeting on techniques and standards for destructive analysis; Salamenca (Spain); 7-9 Mar 1989)			
	15:24034	*See* COGEMA-CONF–89-1			

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CONF-890335–		(1989 IEEE particle accelerator conference; Chicago, IL (USA); 20-23 Mar 1989)			
Vol.1	15:24207	Director, Publishing Services, Institute of Electrical and Electronics Engineers, 345 East 47th Street, New York, NY 10017			ND-414
Vol.2	15:24208	Director, Publishing Services, Institute of Electrical and Electronics Engineers, 345 East 47th Street, New York, NY 10017			ND-414
Vol.3	15:24209	Director, Publishing Services, Institute of Electrical and Electronics Engineers, 345 East 47th Street, New York, NY 10017			ND-414
CONF-890406–		(Fifty years with nuclear fission conference; Gaithersburg, MD (USA); 25-28 Apr 1989)			
	15:25029	*See* CEA-CONF–9906			
CONF-8904153–		(Symposium on nuclear dynamics and nuclear disassembly; Dallas, TX (USA); 9-14 Apr 1989)			
	15:25018	*See* GANIL-P–89-08			
	15:25021	*See* GANIL-P–89-11			
CONF-8904177–		(Symposium on innovative waste management technologies; Dallas, TX (USA); 9-14 Apr 1989)			
	15:24411				
	15:24412				
CONF-8904175–		(Symposium on leaching tests; Dallas, TX (USA); 9-14 Apr 1989)			
	15:23615				
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	15:24424				
CONF-8904233–		(3. international symposium on pion-nucleon and nucleon-nucleon physics; Leningrad (USSR); 22-27 Apr 1989)			
	15:24894	*See* CEA-CONF–9905			
CONF-8904327–		(21. annual Wayne State cancer symposium; Detroit, MI (USA); 13-14 Apr 1989)			
1	15:24715	*See* LA-UR–89-3519			
CONF-890490–		(American Chemical Society Division of Environmental Chemistry meeting; Dallas, TX (USA); 9-14 Apr 1989)			
	15:24425				
CONF-8905219–		(Conference on CP violation in particle physics and astrophysics; Blois (France); 22-26 May 1989)			
3	15:24933	*See* UIUC-HEPG–90-40			
CONF-8905283–		(SHIM 89: 1. international symposium on swift heavy ions in matter; Caen (France); 16-19 May 1989)			
	15:23913	*See* CEA-CONF–9845			
	15:23914	*See* CEA-CONF–9846			
CONF-8905290–		(Seminar on leak-before-break: further developments in regulatory policies and supporting research; Taipei (Taiwan); 11-12 May 1989)			
	15:23784	*See* NUREG/CP–0109			
CONF-8905292–		(Conference on cathodic sputtering; Donji-Milanovac (Yugoslavia); 8-11 May 1989)			
	15:23959	*See* CEA-CONF–9881			
CONF-8905293–		(14. international symposium on cerebral blood flow and metabolism; Bologne (Italy); 28 May - 2 jun 1989)			
	15:24714	*See* CEA-CONF–9900			

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CONF-8905294–		(28. meeting on special steels; Liege (Belgium); 24-25 May 1989)			
	15:23632	*See* CEA-CONF–9891			
CONF-890617–		(2. Karlsruhe international conference on analytical chemistry in nuclear technology; Karlsruhe (Germany, F.R.); 5-9 Jun 1989)			
	15:24030	*See* CEA-CONF–9895			
	15:24031	*See* CEA-CONF–9896			
	15:24032	*See* CEA-CONF–9897			
	15:24033	*See* CEA-CONF–9898			
CONF-890622–		(2. international conference on hot isostatic pressing theory and applications; Gaithersburg, MD (USA); 7-9 Jun 1989)			
	15:23960	*See* CEA-CONF–9899			
CONF-8906225–		(Physics of classical novae: IAU colloquium no. 122; Madrid (Spain); 27-30 Jun 1989)			
3	15:24823	*See* LA-UR–90-870			
5	15:24824	*See* LA-UR–90-876			
CONF-8906266–		(4. All-Union conference on the problems of solvation and complexing in solutions; Ivanovo (USSR); 6-8 Jun 1989)			
	15:24054	*See* INIS-SU–145/A			
CONF-8906269–		(1989 international symposium on in vivo body composition studies; Toronto (Canada); 20-23 Jun 1989)			
7	15:24284	*See* BNL–43977			
CONF-8906298–		(International workshop on proton and narrow photon beam therapy; Oulu (Finland); 8-10 Jun 1989)			
3	15:24716	*See* LBL–28248			
CONF-8906307–		(CSNI specialist meeting on intentional coolant system depressurization; Garching, DE (USA); 12-14 Jun 1989)			
	15:23730	*See* CEA-DAS–619			
CONF-890665–		(7. Institute of Electrical and Electronics Engineers pulsed power conference; Monterey, CA (USA); 12-14 Jun 1989)			
55	15:24280	*See* UCRL–100522			
CONF-890701–		(International cryogenic materials conference; Los Angeles, CA (USA); 24-28 Jul 1989)			
27	15:24258	*See* FNAL-TM–1621			
CONF-890705–		(8. international zeolite conference; Amsterdam (Netherlands); 10-14 Jul 1989)			
3	15:23983	*See* BNL–43937			
CONF-8907134–		(17. SLAC summer institute: physics at the '100 GeV mass scale; Stanford, CA (USA); 10-21 Jul 1989)			
7	15:24930	*See* LBL–28556			
CONF-890786–		(US particle accelerator school; Upton, NY (USA); 24 Jul - 4 aug 1989)			
1	15:24210	*See* BNL–43914			
CONF-890802–		(7. synchrotron radiation instrumentation (SRI) national conference; Berkeley, CA (USA); 6-10 Aug 1989)			
25	15:24245	*See* LBL–28222			
CONF-8908141–		(U.S. Department of Energy conference on technology research and development for arms control verification; Los Alamos, NM (USA); 29-31 Aug 1989)			
4	15:23898	*See* UCRL–101686			
CONF-8908217–		(9. international conference on crystal growth; Sendai (Japan); 20-25 Aug 1989)			
	15:24306	*See* LAPP-EXP–89-05			
CONF-890872–		(Workshop on physics at Fermilab in the 1990's; Breckenridge, CO (USA); 15-24 Aug 1989)			
7	15:24893	*See* FNAL-TM–1636			
8	15:24212	*See* FNAL/C–90/29-T			
CONF-8909107–		(ECFA study week on instrumentation technology for high luminosity hadron colliders; Barcelona (Spain); 14-21 Sep 1989)			
	15:24286	*See* CERN–89-10(v.1/2)			

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CONF-890916–		(6. annual international Pittsburgh coal conference; Pittsburgh, PA (USA); 25-29 Sep 1989)			
	15:23361	*See* BG-MRS-E–571			
CONF-8909190–		(Technical exchange meeting on assessing indoor radon health risks; Grand Junction, CO (USA); 18-19 Sep 1989)			
1	15:23868	*See* PNL-SA–17851			
CONF-8909210–		(12. Werner Brandt international workshop on charged particle penetration phenomena; San Sebastian (Spain); 4-7 Sep 1989)			
9	15:25067	NTIS, PC A03/MF A01 - OSTI		DE90008558	MF-404
10	15:25068	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008570	MF-414
11	15:25109	*See* UCRL–101624			
CONF-8909247–		(ACS symposium on exotic nuclear spectroscopy; Miami Beach, FL (USA); 11-15 Sep 1989)			
7	15:25056	*See* LBL–28172			
CONF-8909306–		(International conference on modeling of global climate change and variability; Hamburg (Germany, F.R.); Sep 1989)			
1	15:24383	*See* UCRL–102793			
CONF-8909313–		(SIAM conference on mathematical and computational issues in geophysical fluid and solid mechanics; Houston, TX (USA); 25-29 Sep 1989)			
1	15:24819	*See* UCRL–102729			
CONF-890935–		(International workshop on new developments in occupational dose control and ALARA implementation at nuclear power plants and similar facilities; Upton, NY (USA); 18-21 Sep 1989)			
	15:23785	*See* NUREG/CP–0110			
CONF-890975–		(7. international conference on heavy metals in the environment; Geneva (Switzerland); 12-15 Sep 1989)			
4	15:24363	*See* NILU-F–9/89			
CONF-890982–		(Specialists' meeting on neutron activation cross sections for fission and fusion energy applications; Argonne, IL (USA); 13-15 Sep 1989)			
	15:25191	*See* NEANDC–259-U			
CONF-891001–		(International conference on coal science; Tokyo (Japan); 23-27 Oct 1989)			
12	15:23720	*See* BNL–41973			
CONF-8910107–		(Electrochemical Society fall meeting; Hollywood, FL (USA); 15-20 Oct 1989)			
10	15:23886	*See* UCRL–21264			
11	15:23800	*See* LBL–27964			
CONF-8910222–		(17. water reactor safety information meeting; Rockville, MD (USA); 23-25 Oct 1989)			
17	15:23774	*See* BNL-NUREG–43960			
18	15:23773	*See* BNL-NUREG–43173			
19	15:23772	*See* BNL-NUREG–43152			
CONF-8910363–		(Society for Risk Analysis annual meeting; San Francisco, CA (USA); 29 Oct - 1 nov 1989)			
1	15:23779	*See* EGG-M–89191			
CONF-8910365–		(C.R.M. workshop on Hamiltonian Systems: transformation groups and spectral transform methods; Montreal (Canada); 20-26 Oct 1989)			
1	15:25107	*See* LA-UR–90-537			
CONF-8910357–		(3. international conference of anticarcinogens and radiation protection; Dubrovnik (Yugoslavia); 15-21 Oct 1989)			
1	15:24721	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007804	MF-408
CONF-8910372–		(Joint Japanese-American workshop on future trends in logic programming; Argonne, IL (USA); 11-13 Oct 1989)			
	15:25225	*See* ANL–89/43			
CONF-891044–		(1. international conference on radioactive nuclear beams; Berkeley, CA (USA); 16-18 Oct 1989)			
9	15:24217	*See* LBL–28319			

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CONF-891053–		(28. Hanford life sciences symposium on environmental monitoring, restoration and assessment: what have we learned?; Richland, WA (USA); 16-19 Oct 1989)			
18	15:24380	*See* PNL-SA–16909			
CONF-891061–		(Direct liquefaction contractors' review meeting; Pittsburgh, PA (USA); 2-4 Oct 1989)			
	15:23265	NTIS, PC A14/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008423	MF-108
CONF-891098–		(The scientific challenge of NEPA: future directions based on 20 years of experience; Knoxville, TN (USA); 24-27 Oct 1989)			
6	15:24433	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008563	MF-402
CONF-8911172–		(Symposium on muon catalyzed fusion phenomena; Tokyo (Japan); 2-4 Nov 1989)			
1	15:25113	*See* LA-UR–90-370			
CONF-8911175–		(Workshop on future climate change and radioactive waste disposal; Norwich (UK); 1-3 Nov 1989)			
1	15:23576	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008746	MF-402
CONF-891119–		(Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989)			
109	15:23605	*See* UCRL–100860			
111	15:23593	*See* PNL-SA–17194			
112	15:23966	*See* PNL-SA–17271			
113	15:23965	*See* PNL-SA–17226			
CONF-891120–		(Migration '89: 2nd international conference on chemistry and migration behavior of actinides and fission products in the geosphere; Monterey, CA (USA); 6-10 Nov 1989)			
11	15:23592	*See* PNL-SA–17157			
12	15:23597	*See* PNL-SA–17319			
CONF-891130–		(3. international conference on processing and utilization of high-sulphur coals; Ames, IA (USA); 14-18 Nov 1989)			
3	15:23260	*See* DOE/PETC/TR–89/9			
CONF-891131–		(Indirect liquefaction contractors' review meeting; Pittsburgh, PA (USA); 13-15 Nov 1989)			
	15:23266	NTIS, PC A20/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008422	MF-108
CONF-891173–		(Roof wind uplift testing workshop; Oak Ridge, TN (USA); 8-9 Nov 1989)			
	15:23857	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008041	MF-400
CONF-891204–		(4. international conference on fusion reactor materials; Kyoto (Japan); 4-8 Dec 1989)			
26	15:25193	*See* PNL-SA–16981			
CONF-891273–		(4. SIAM conference on parallel processing for scientific computing; Chicago, IL (USA); 11-13 Dec 1989)			
3	15:25226	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008902	MF-405
CONF-891276–		(Workshop on high energy astrophysics in the 21st century; Taos, NM (USA); 10-14 Dec 1989)			
6	15:24312	*See* UCRL–102559			
CONF-891280–		(1989 ASAE winter meeting; New Orleans, LA (USA); 11 Dec 1989)			
1	15:23877	*See* EGG-M–89483			
CONF-891282–		(IMA conference on cryptography and coding; Cirencester (UK); 18-20 Dec 1989)			
1	15:25253	*See* SAND–89-2783C			
CONF-900123–		(Physics and chemistry of semiconductor interfaces; Clearwater Beach, FL (USA); 31 Jan - 2 feb 1990)			
1	15:23993	*See* UCRL-JC–103212			
CONF-900136–		(9. ASME wind energy symposium; New Orleans, LA (USA); 14-17 Jan 1990)			
8	15:23709	*See* SERI/TP–257-3603			
CONF-900140–		(SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition; Los Angeles, CA (USA); 15-19 Jan 1990)			
14	15:24281	*See* UCRL–102538			
15	15:24190	*See* UCRL–102739			

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CONF-900143–		(Institute for Electronic and Electrical Engineers (IEEE) nuclear science symposium; San Francisco, CA (USA); 15-19 Jan 1990)			
30	15:23756	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007797	MF-541
CONF-900153–		(28. AIAA aerospace sciences meeting; Reno, NV (USA); 8-11 Jan 1990)			
	15:24159	*See* N–90-13749			
CONF-900156–		(2. international symposium on advanced nuclear energy research - evolution by accelerators; Mito (Japan); 24-26 Jan 1990)			
4	15:23562	*See* BNL–43887			
CONF-900161–		(7. Institute of Nuclear Materials Management spent fuel management seminar; Washington, DC (USA); 17-19 Jan 1990)			
5	15:23541	*See* PNL-SA–17727			
CONF-900178–		(Biomedical optics '90; Los Angeles, CA (USA); 14-19 Jan 1990)			
1	15:24783	*See* LA-UR–90-445			
CONF-900202–		(IEEE Power Engineering Society winter meeting; Atlanta, GA (USA); 4-9 Feb 1990)			
6	15:23797	*See* PNL-SA–17339			
CONF-900206–		(119. TMS (The Minerals, Metals & Metallurgical Society) annual meeting and exhibit; Anaheim, CA (USA); 18-22 Feb 1990)			
4	15:23940	*See* UCRL–102971			
5	15:23920	*See* EGG-M–89453			
6	15:23967	*See* PNL-SA–17450			
CONF-900210–		(16. annual waste management symposium: working towards a cleaner environment; Tucson, AZ (USA); 25 Feb - 1 mar 1990)			
25	15:23613	*See* WHC-SA–0711			
26	15:23563	*See* BNL-NUREG–43926			
27	15:23564	*See* BNL-NUREG–43927			
29	15:23618	*See* PNL-SA–17283			
30	15:23596	*See* PNL-SA–17285			
31	15:23624	*See* PNL-SA–17336			
32	15:23623	*See* PNL-SA–17282			
33	15:23793	*See* PNL-SA–17794			
34	15:23595	*See* PNL-SA–17284			
35	15:23594	*See* PNL-SA–17242			
CONF-9002100–		(International group on research reactors conference; Knoxville, TN (USA); 28 Feb - 2 mar 1990)			
1	15:23777	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008744	MF-330
CONF-9002103–		(Ground-water geochemistry conference; Kansas, MO (USA); 20-22 Feb 1990)			
1	15:24700	*See* PNL-SA–17289			
CONF-9002104–		(11. AESF/EPA conference on pollution control for the metal finishing industry; Miami, FL (USA); 5-9 Feb 1990)			
1	15:23599	*See* PNL-SA–17690			
CONF-900223–		(2. international conference on nuclear microprobe technology and applications; Melbourne (Australia); 5-9 Feb 1990)			
3	15:24218	*See* UCRL–102244			
CONF-900246–		(23. Health Physics Society midyear topical symposium on risk analysis; Atlantic City, NJ (USA); 4-9 Feb 1990)			
5	15:24736	*See* PNL-SA–17037			
CONF-900255–		(Southeast regional climate symposium: global change - a southern perspective; Charleston, SC (USA); 19-22 Feb 1990)			
1	15:24351	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008741	MF-402
CONF-900264–		(Topical conference on research trends in nonlinear and relativistic effects in plasmas; San Diego, CA (USA); 5-8 Feb 1990)			
3	15:24237	*See* FNAL/C–90/40			
4	15:24837	*See* LA-UR–90-1000			

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CONF-900285–		(SPIE astronomical telescopes and instrumentation for the 21st century symposium; Tucson, AZ (USA); 11-17 Feb 1990)			
2	15:24317	*See* UCRL–101575			
3	15:25249	*See* UCRL–101573			
CONF-900287–		(TMS symposium on high temperature superconducting compounds; Anaheim, CA (USA); 20-21 Feb 1990)			
1	15:23963	*See* LA-UR–90-449			
CONF-9003102–		(12. U.S. TRIGA users conference; Austin, TX (USA); 11-14 Mar 1990)			
1	15:23794	*See* WHC-SA–0865			
CONF-9003104–		(GIS '90 conference; Vancouver (UK); 12-16 Mar 1990)			
1	15:25250	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008749	MF-400
CONF-9003106–		(Spring optical show of the Optical Society of Northern California; Palo Alto, CA (USA); 29 Mar 1990)			
1	15:24318	*See* UCRL–102996			
CONF-9003107–		(ARMA Region X association of records managers and administrators conference; Boise, ID (USA); 7-9 Mar 1990)			
1	15:25252	*See* PNL-SA–17266			
CONF-9003111–		(1990 international manufacturing conference; Atlanta, GA (USA); 26 Mar 1990)			
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3	15:25074	*See* LA-UR–90-839			
CONF-900377–		(Energy and the environment in the 21st century; Cambridge, MA (USA); 26-28 Mar 1990)			
3	15:23666	*See* SAND–90-0438C			
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CONF-900397–		(1. Los Alamos symposium on ultra-wideband radar; Los Alamos, NM (USA); 5-8 Mar 1990)			
1	15:24307	*See* LA-UR–90-472			
CONF-900403–		(NACE Corrosion '90; Las Vegas, NV (USA); 23-27 Apr 1990)			
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CONF-9004138–		(3. Canadian Nuclear Society international conference on simulation methods in nuclear engineering; Montreal (Canada); 18-20 Apr 1990)			
3	15:23771	*See* BNL–43929			
CONF-9004146–		(16. DOE compatibility, aging and service life conference; Livermore, CA (USA); 24-26 Apr 1990)			
1	15:23990	*See* SAND–90-0653C			
2	15:23989	*See* SAND–90-0648C			
3	15:24335	*See* SAND–90-0751C			
CONF-9004147–		(1990 JANNAF propulsion systems hazards meeting; Laurel, MD (USA); 3-5 Apr 1990)			
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2	15:24331	*See* SAND–89-2580C			
CONF-900418–		(International conference on the physics of reactors: operation, design and computation; Marseilles (France); 23-26 Apr 1990)			
8	15:25108	*See* UCRL–101560			
CONF-900419–		(8. international triennial conference on thin films and the 17th international conference on metallurgical coatings; San Diego, CA (USA); 1-6 Apr 1990)			
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CONF-9005132–		(CompEuro '90 conference; Tel Aviv (Israel); 7-9 May 1990)			
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5249	15:24159	*See* N–90-13749			
ECFA–					
89-124	15:24286	*See* CERN–89-10(v.1/2)			

ECN–

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ECN–					
224	15:25189	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90706067	
ED–					
89-476	15:24973	*See* RAL–89-115			
EGG-M–					
88425	15:23919	NTIS, PC A; GPO Dep.	E 1.99:	DE90007018	MF-313
89191	15:23779	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007021	
89453	15:23920	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007013	MF-313
89483	15:23877	NTIS, PC A03/MF A01; OSTI; INIS		DE90007042	MF-314
EPA–					
230/03-89/043	15:24482	*See* PB–90-137316/XAB			
230/03-89/044	15:24483	*See* PB–90-137324/XAB			
230/03-89/045	15:24484	*See* PB–90-137332/XAB			
230/03-89/046	15:24485	*See* PB–90-137340/XAB			
440/1-89/014	15:23496	*See* PB–90-126509/XAB			
440/1-89/050	15:24442	*See* PB–90-126475/XAB			
440/1-89/084	15:24447	*See* PB–90-126533/XAB			
440/1-89/100	15:24445	*See* PB–90-126517/XAB			
440/1-89/101	15:24444	*See* PB–90-126491/XAB			
440/1-89/102	15:24441	*See* PB–90-126467/XAB			
440/1-89/103	15:24448	*See* PB–90-126541/XAB			
440/1-89/104	15:24443	*See* PB–90-126483/XAB			
440/1-89/105	15:23495	*See* PB–90-126434/XAB			
440/1-89/106	15:24446	*See* PB–90-126525/XAB			
540/8-89/009	15:23824	*See* PB–90-153883/XAB			
600/8-88/054	15:24758	*See* PB–90-142357/XAB			
600/8-89/085	15:24759	*See* PB–90-142373/XAB			
600/8-89/086	15:24760	*See* PB–90-142381/XAB			
600/8-89/087	15:24761	*See* PB–90-142399/XAB			
600/8-89/092	15:24762	*See* PB–90-142449/XAB			
600/8-89/094	15:24763	*See* PB–90-142464/XAB			
600/8-89/095	15:24764	*See* PB–90-142472/XAB			
600/8-89/096	15:24765	*See* PB–90-142480/XAB			
600/8-89/097	15:24766	*See* PB–90-142498/XAB			
600/8-89/098	15:24767	*See* PB–90-142506/XAB			
600/8-89/099	15:24768	*See* PB–90-142514/XAB			
600/D-89/222	15:24371	*See* PB–90-134297/XAB			
600/D-89/229	15:24451	*See* PB–90-134362/XAB			
600/D-89/231	15:24452	*See* PB–90-134388/XAB			
600/D-89/234	15:24396	*See* PB–90-134412/XAB			
600/D-89/267	15:24450	*See* PB–90-132473/XAB			
600/D-89/269	15:24481	*See* PB–90-137068/XAB			
600/D-89/270	15:24395	*See* PB–90-134180/XAB			
600/J-89/177	15:24754	*See* PB–90-140732/XAB			
600/J-89/180	15:24540	*See* PB–90-140898/XAB			
600/J-89/185	15:24517	*See* PB–90-138447/XAB			
600/J-89/186	15:24518	*See* PB–90-138454/XAB			
600/J-89/200	15:23719	*See* PB–90-140757/XAB			
600/J-89/218	15:24771	*See* PB–90-146127/XAB			
600/J-89/224	15:24770	*See* PB–90-146069/XAB			
600/J-89/232	15:24729	*See* PB–90-145988/XAB			
600/J-89/241	15:24372	*See* PB–90-135278/XAB			
EPA/ROD/R–					
01-89/036	15:24515	*See* PB–90-138397/XAB			
02-89/081	15:24513	*See* PB–90-138363/XAB			
03-89/071	15:24514	*See* PB–90-138389/XAB			
03-89/080	15:24510	*See* PB–90-138322/XAB			
05-89/099	15:23382	*See* PB–90-138355/XAB			
05-89/111	15:24516	*See* PB–90-138405/XAB			
06-89/053	15:24512	*See* PB–90-138348/XAB			
09-89/035	15:24511	*See* PB–90-138330/XAB			
09-89/036	15:24509	*See* PB–90-138314/XAB			
EPRI-CU–					
6755	15:23878	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6775	15:23879	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6777	15:23860	Research Reports Center, Box 50490, Palo Alto, CA 94303			

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6770	15:23714	Research Reports Center, Box 50490, Palo Alto, CA 94303			
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6676	15:23780	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6733	15:23724	Research Reports Center, Box 50490, Palo Alto, CA 94303			
ERP/CRL–					
87-135(J)	15:23261	Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Coal Research Labs.			
87-22(TR)	15:23396	Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Coal Research Lab.			
88-37(OP)	15:23397	Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Coal Research Lab.			
88-65(OP)	15:23357	Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Coal Research Lab.			
88-66(OP,J)	15:23398	Canadian Centre for Mineral and Energy Technology, Sydney, NS (Canada). Cape Breton Coal Research Lab.			
88-68(TR)	15:23410	Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Coal Research Lab.			
88-69(J)	15:23379	Canada Centre for Mineral and Energy Technology, Sydney, NS (Canada). Cape Breton Coal Research Lab.			
88-71(OP,J)	15:23399	Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Coal Research Lab.			
88-74(TR)	15:23358	Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Coal Research Lab.			
88-76(TR)	15:23400	Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Coal Research Lab.			
89-51(TR)	15:23401	Canada Centre for Mineral and Energy Technology, Sydney, NS (Canada). Cape Breton Coal Research Lab.			
89-52(TR)	15:23402	Canada Centre for Mineral and Energy Technology, Sydney, NS (Canada). Cape Breton Coal Research Lab.			
89-53(TR)	15:23403	Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Surface Mining Lab.			
89-54(OP,J)	15:23404	Canada Centre for Mineral and Energy Technology, Devon, AB (Canada). Surface Mining Lab.			
89-79(OP)	15:23395	Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Coal Research Lab.			
ESC–					
51	15:23873	NTIS (US Sales Only), PC A09/MF A01		DE90752614	
52	15:23893	NTIS (US Sales Only), PC A05/MF A01		DE90752613	
ETDE/OA–					
37	15:23832	NTIS, PC A03/MF A01 - OSTI		DE90008596	
ETSU-N–					
114	15:23694	Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks.			

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EUR–					
11401-EN	15:23350	Commission of the European Communities, Luxembourg			
EWE–					
2650.3	15:23757	*See* DOE-RW–89.094			
FCR–					
10570A	15:23852	*See* PB–90-148065/XAB			
FDA/OMO–					
90/14D	15:24730	*See* PB–90-920999/XAB			
FERMILAB-PUB–					
89/205-A	15:24825	*See* N–90-14164			
89/214-A	15:24826	*See* N–90-14180			
89/239-A	15:24827	*See* N–90-15016			
FNAL-TM–					
1587	15:23985	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007906	PC-404
1615	15:24213	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007908	PC-404
1621	15:24258	NTIS, PC A02/MF A01; OSTI; INIS		DE90007909	PC-414
1636	15:24893	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007905	PC-405
1641	15:24259	NTIS, PC A08/MF A01; OSTI; INIS		DE90007910	PC-406
1646	15:24238	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007907	PC-414
FNAL/C–					
90/29-T	15:24212	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008811	MF-414
90/40	15:24237	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008812	MF-414
FRNC-TH–					
3467	15:24391	NTIS (US Sales Only), PC A08/MF A01		DE90762017	
3468	15:24723	NTIS (US Sales Only), PC A09/MF A01		DE90762019	
3470	15:23781	NTIS (US Sales Only), PC A06/MF A01		DE90762016	
3494	15:23758	NTIS (US Sales Only), PC A09/MF A01		DE90762018	
FSGTR-RM–					
177	15:23826	*See* PB–90-148313/XAB			
GANIL-P–					
89-08	15:25018	NTIS (US Sales Only), PC A03/MF A01		DE90762028	
89-11	15:25021	NTIS (US Sales Only), PC A03/MF A01		DE90762029	
GL–					
3783	15:23908	*See* AD-A–215334/4/XAB			
GPO–					
24-159	15:24382	*See* S-HRG–101-377			
GRI–					
89/0292	15:23867	*See* PB–90-148081/XAB			
GTFR–					
90	15:25149	*See* PB–90-135724/XAB			
HCR-CDM–					
09	15:24053	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621091	
HCR-CDTN–					
10	15:24720	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621671	
IAEA-TECDOC–					
502	15:24792	NTIS (US Sales Only), PC A21/MF A01; OSTI; INIS		DE90621477	
IGT–					
90008818	15:23527	OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616		TI90008818	
IJS-P–					
300	15:25208	NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS		DE90622160	
301	15:25209	NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS		DE90622161	
IKU-R–					
34.2776.00/01/88	15:23715	NTIS (US Sales Only), PC A04/MF A01		DE90760288	
IL/SGS/EGN–					
106	15:23392	*See* PB–90-148743/XAB			
INDC(JPN)–					
135/L	15:24991	*See* JAERI-M–90-024			
INIS-SU–					
145/A	15:24054	NTIS (US Sales Only), PC A15/MF A01 - OSTI; INIS		DE90706029	
147/A	15:24010	NTIS (US Sales Only), PC A11/MF A01 - OSTI; INIS		DE90706030	
INIS-mf–					
11570	15:24357	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90706068	

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ISCR–					
1989-01	15:25245	*See* UCID–21964			
IWGFPT–					
27	15:23782	NTIS (US Sales Only), PC A12/MF A01; OSTI; INIS		DE90621928	
JA–					
6222	15:23956	*See* AD-A–215510/9/XAB			
6262	15:24326	*See* AD-A–215520/8/XAB			
6280	15:24180	*See* AD-A–215514/1/XAB			
JAERI-M–					
90-024	15:24991	Japan Atomic Energy Research Institute, Dept. of Technical Information, Tokai-mura, Naka-gun, Ibaraki-ken 319-11, Japan			
JINR–					
12-88-500	15:24117	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621261	
13-88-437	15:24288	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622007	
13-88-489	15:24289	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621972	
13-88-567	15:24290	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621979	
13-88-586	15:24261	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621882	
13-88-621	15:24843	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620558	
13-88-627	15:24291	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622008	
13-88-636	15:24181	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622047	
13-88-686	15:24292	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622009	
13-88-687	15:24293	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622152	
13-88-733	15:24214	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621857	
13-88-757	15:24294	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622010	
13-88-827	15:24262	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621872	
16-88-613	15:24263	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90621883	
18-88-549	15:24112	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621332	
18-88-603	15:25093	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620465	
18-88-713	15:23986	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621463	
18-88-759	15:23766	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621901	
9-88-676	15:23921	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621420	
9-88-846	15:24260	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621884	
JINR-D–					
1-88-691	15:24992	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620962	
1-88-932	15:24897	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620889	
13-88-614	15:24295	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90621999	
13-88-764	15:24296	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622000	
14-88-667	15:25090	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620802	
JINR-E–					
1-88-476	15:24898	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620890	
1-88-639	15:25009	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620979	
1-88-651	15:24899	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620891	

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1-88-754	15:25031	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620927	
13-88-566	15:24297	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90621978	
13-88-729	15:24298	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622001	
15-88-864	15:25010	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620980	
17-88-822	15:25071	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620561	
18-88-540	15:24113	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621331	
19-88-511	15:24724	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90621575	
2-88-498	15:25032	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620928	
2-88-553	15:24951	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620510	
2-88-558	15:24914	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620831	
2-88-570	15:24967	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620476	
2-88-588	15:25033	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620925	
2-88-600	15:24968	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620477	
2-88-607	15:24952	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620511	
2-88-609	15:24996	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620966	
2-88-648	15:24915	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620832	
2-88-653	15:25094	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620462	
2-88-658	15:24953	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620512	
2-88-670	15:24954	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620513	
2-88-678	15:25095	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620448	
2-88-682	15:24969	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620478	
2-88-695	15:24955	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620514	
2-88-701	15:24956	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620515	
2-88-705	15:24957	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620516	
2-88-706	15:24958	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620517	
2-88-717	15:24916	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620833	
2-88-732	15:25034	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622147	
2-88-783	15:24970	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620479	
2-88-792	15:24821	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622139	
2-88-793	15:24917	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620834	
2-88-809	15:24918	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620835	
2-88-840	15:24919	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620836	
2-88-877	15:24920	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620837	
2-88-915	15:24921	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620838	
4-88-536	15:24922	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620869	
4-88-673	15:25035	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620929	

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4-88-688	15:25096	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620449	
4-88-737	15:25036	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620906	
4-88-780	15:25037	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620930	
4-88-800	15:25038	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620953	
4-88-802	15:25123	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620643	
4-88-808	15:25039	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620931	
4-88-849	15:24844	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620538	
4-88-886	15:25040	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620907	
4-89-94	15:25041	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620954	
5-88-623	15:25097	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620450	
5-88-659	15:24971	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620480	
5-88-700	15:25098	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620442	
6-88-578	15:24988	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620955	
6-88-594	15:24118	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621252	
7-88-803	15:25022	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620992	
JINR-R-					
1-88-312	15:25019	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620990	
1-88-397	15:24900	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620892	
1-88-406	15:24989	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620956	
1-88-408	15:24299	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622002	
1-88-414	15:24300	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622003	
1-88-469	15:24997	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620967	
1-88-503	15:24993	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620963	
1-88-516	15:24301	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622004	
1-88-546	15:24998	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620968	
1-88-645	15:24999	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620969	
1-88-685	15:25000	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620970	
1-88-741	15:24845	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620541	
1-88-780	15:25042	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620932	
1-88-796	15:24901	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620893	
1-88-821	15:24990	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620957	
1-88-858	15:25013	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620987	
1-88-905	15:25001	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620971	
10-88-505	15:24182	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622044	
10-88-692	15:25231	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622148	
10-88-742	15:24302	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622005	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
11-88-335	15:24268	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621876	
11-88-506	15:24929	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620839	
11-88-606	15:24239	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621860	
11-88-608	15:24269	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621879	
11-88-683	15:24240	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622140	
11-88-714	15:24241	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90621861	
11-88-716	15:25232	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622141	
11-88-722	15:25233	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622142	
11-88-744	15:25234	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622143	
11-88-745	15:24850	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622149	
13-88-485	15:24303	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622006	
13-88-554	15:24270	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621880	
13-88-750	15:24321	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622045	
13-88-751	15:24271	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621877	
13-88-770	15:24304	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622029	
13-88-776	15:24272	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621881	
14-88-571	15:25073	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620562	
14-88-572	15:23961	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621440	
19-88-646	15:24725	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621555	
19-88-766	15:24726	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90621576	
2-88-375	15:25099	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620443	
2-88-560	15:24923	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620840	
2-88-615	15:24311	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622150	
2-88-668	15:25100	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620444	
2-88-724	15:25101	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620451	
2-88-725	15:25102	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620452	
2-88-769	15:24972	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622151	
2-88-773	15:24822	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620792	
2-88-778	15:25103	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620463	
2-88-801	15:24924	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620841	
2-88-828	15:24925	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620817	
2-88-832	15:24926	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620842	
2-88-874	15:24846	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620542	
2-88-888	15:24927	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620843	
2-88-898	15:25043	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620933	
3-88-394	15:25065	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620897	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
3-88-767	15:25230	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90622144	
3-88-806	15:25011	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620981	
3-88-824	15:25014	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620988	
3-88-908	15:25002	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620972	
4-88-528	15:25044	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620934	
4-88-634	15:25104	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620464	
4-88-640	15:24847	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620526	
4-88-642	15:25045	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620935	
4-88-660	15:25046	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620908	
4-88-693	15:25072	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620563	
4-88-708	15:24928	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620818	
4-88-718	15:25047	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620909	
4-88-735	15:25048	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620910	
4-88-746	15:24848	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620543	
4-88-747	15:24849	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622145	
4-88-763	15:25049	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620911	
4-88-799	15:25050	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620912	
4-88-845	15:25051	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620913	
4-88-848	15:25052	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620936	
4-88-933	15:25053	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620914	
5-88-649	15:25105	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620453	
5-88-782	15:25106	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620454	
6-88-635	15:24119	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90621276	
6-88-755	15:25012	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620982	
6-88-756	15:25054	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620950	
7-88-596	15:24320	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90622046	
7-88-830	15:25020	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620991	
9-88-629	15:24215	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621855	
9-88-637	15:24264	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90621873	
9-88-707	15:24265	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90621874	
9-88-872	15:24266	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621870	
9-88-895	15:24267	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621871	
9-89-26	15:24216	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621856	
K/CSD/INF–88/23	15:24102	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008733	MF-705
K/CSD/TM–85	15:24103	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008172	MF-505

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K/DSRD–					
276	15:25235	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008852	
K/ETO–					
21	15:23987	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008732	MF-501
KCP–					
613-4202	15:24041	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008161	PC-701
KFTI–					
88-2	15:24242	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621864	
88-3	15:25124	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620581	
88-4	15:25125	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620704	
88-5	15:25126	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620705	
88-6	15:25127	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620690	
88-7	15:25128	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620656	
88-8	15:25055	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620937	
88-9	15:25129	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620644	
88-10	15:25130	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620580	
88-11	15:24243	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90621862	
88-12	15:24244	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90621863	
88-13	15:24851	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90620544	
LA–					
11768-MS	15:23962	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008519	MF-704
11774-MS	15:24341	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008028	PC-706
11778-MS	15:24183	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007711	MF-714
11782-MS	15:24342	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008016	PC-700
11831-MS	15:25239	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007918	MF-905
LA-UR–					
89-3519	15:24715	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90002401	MF-408
90-1000	15:24837	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008918	MF-706
90-370	15:25113	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007547	MF-411
90-445	15:24783	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007626	MF-700; MF-708
90-449	15:23963	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007528	MF-332
90-472	15:24307	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007532	MF-706
90-510-Rev.	15:23796	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007538	MF-900
90-537	15:25107	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007540	MF-705
90-839	15:25074	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008941	MF-910; MF-906
90-870	15:24823	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008938	MF-910
90-876	15:24824	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008934	MF-910
90-966	15:23629	*See* SAND–90-0859C			
LAPP-EXP–					
89-03	15:24305	NTIS (US Sales Only), PC A02/MF A01		DE90762034	
89-05	15:24306	NTIS (US Sales Only), PC A02/MF A01		DE90762033	
LBH–					
488-566	15:23493	PC British Columbia Legislative Library, Government Documents Division, Parliament Buildings, Victoria, BC, CAN V8V 1X4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
LBL–					
25430	15:23861	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007773	MF-350
25746	15:25251	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008711	MF-405
27872	15:23889	NTIS, PC A16/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008075	MF-350
27964	15:23800	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008665	MF-212
28083	15:23801	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008667	MF-201
28104	15:24055	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008668	MF-401
28172	15:25056	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008666	MF-413

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28222	15:24245	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009049	MF-414
28248	15:24716	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008664	MF-408
28319	15:24217	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009216	MF-414
28556	15:24930	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009218	MF-414
LLNL-M–					
243-Vol.1	15:23814	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008687	MF-700
243-Vol.2	15:23815	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008688	MF-700
256	15:24143	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008544	MF-706
LRP–					
340/88	15:25131	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620582	
344/88	15:25132	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620584	
350/88	15:25133	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620596	
351/88	15:25134	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620597	
353/88	15:25135	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620598	
354/88	15:25136	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620599	
355/88	15:25137	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620600	
356/88	15:25138	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620601	
357/88	15:25139	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620602	
360/88	15:24959	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620518	
361/88	15:25140	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620604	
362/88	15:25141	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620692	
363/88	15:25142	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620605	
374/89	15:25143	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90620606	
376/89	15:25144	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90620693	
377/89	15:25145	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620607	
378/89	15:25146	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620608	
380/89	15:25147	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620609	
MICROLOG–					
90-00023	15:23493	*See* LBH–488-566			
90-00372	15:23532	*See* AOSTRA–8844			
MINTEK-M–					
395	15:24042	Available from Mintek, Private Bag X3015, Randburg, 2125, South Africa			
MLM–					
3627	15:24329	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008177	PC-741
3629	15:24330	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008176	PC-704
MRP/MSL–					
88-41(OP&J)	15:23453	Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Mineral Sciences Labs., Extractive Metallurgy Lab.			
MS–					
8144	15:24177	*See* AD-A–215389/8/XAB			
8238	15:24179	*See* AD-A–215511/7/XAB			
MW–					
89-P-6	15:24178	*See* AD-A–215463/1/XAB			
N–					
90-13749	15:24159	NTIS, PC A03/MF A01			
90-13772	15:24184	NTIS, PC A04/MF A01			
90-14164	15:24825	NTIS, PC A02/MF A01			
90-14180	15:24826	NTIS, PC A03/MF A01			
90-14279	15:23738	NTIS, PC A07/MF A01			
90-14583	15:24185	NTIS, PC A03/MF A01			
90-15016	15:24827	NTIS, PC A04/MF A01			

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90-15025	15:24828	NTIS, PC A03/MF A01			
NAS–					
1.15:102469	15:24159	*See* N–90-13749			
1.26:183290	15:24184	*See* N–90-13772			
1.26:185916	15:24828	*See* N–90-15025			
1.26:185947	15:23738	*See* N–90-14279			
1.26:186077	15:24826	*See* N–90-14180			
1.26:186079	15:24825	*See* N–90-14164			
1.26:186168	15:24827	*See* N–90-15016			
1.26:186194	15:24185	*See* N–90-14583			
NASA-CR–					
183290	15:24184	*See* N–90-13772			
185916	15:24828	*See* N–90-15025			
185947	15:23738	*See* N–90-14279			
186077	15:24826	*See* N–90-14180			
186079	15:24825	*See* N–90-14164			
186168	15:24827	*See* N–90-15016			
186194	15:24185	*See* N–90-14583			
NASA-TM–					
102469	15:24159	*See* N–90-13749			
NCEL-TN–					
1801	15:23795	*See* AD-A–215444/1/XAB			
NEANDC(J)–					
148/U	15:24991	*See* JAERI-M–90-024			
NEANDC–					
259-U	15:25191	Organisation for Economic Co-operation and Development, 2, rue Andre-Pascal, 75775 Paris Cedex 16, France			
NEI-DK–					
260	15:23862	NTIS (US Sales Only), PC A05/MF A01		DE90760173	
261	15:23865	NTIS (US Sales Only), PC A03/MF A01		DE90760181	
262	15:23648	NTIS (US Sales Only), PC A05/MF A01		DE90760182	
263	15:23649	NTIS (US Sales Only), PC A05/MF A01		DE90760183	
264	15:23802	NTIS (US Sales Only), PC A12/MF A01		DE90760200	
265	15:23642	NTIS (US Sales Only), PC A04/MF A01		DE90760214	
266	15:24360	NTIS (US Sales Only), PC A03/MF A01		DE90760215	
267	15:23529	NTIS (US Sales Only), PC A04/MF A01		DE90760216	
268	15:23845	NTIS (US Sales Only), PC A05/MF A01		DE90760217	
269	15:23846	NTIS (US Sales Only), PC A04/MF A01		DE90760218	
270	15:23847	NTIS (US Sales Only), PC A04/MF A01		DE90760219	
271	15:23848	NTIS (US Sales Only), PC A05/MF A01		DE90760220	
272	15:23704	NTIS (US Sales Only), PC A03/MF A01		DE90760222	
273	15:23705	NTIS (US Sales Only), PC A04/MF A01		DE90760225	
274	15:23706	NTIS (US Sales Only), PC A03/MF A01		DE90760226	
275	15:23654	NTIS (US Sales Only), PC A07/MF A01		DE90760228	
276	15:23850	NTIS (US Sales Only), PC A04/MF A01		DE90760229	
277	15:23488	NTIS (US Sales Only), PC A05/MF A01		DE90760230	
278	15:23717	NTIS (US Sales Only), PC A06/MF A01		DE90760233	
280	15:23643	NTIS (US Sales Only), PC A03/MF A01		DE90760234	
281	15:23650	NTIS (US Sales Only), PC A03/MF A01		DE90760235	
282	15:23851	NTIS (US Sales Only), PC A06/MF A01		DE90760241	
284	15:23816	NTIS (US Sales Only), PC A05/MF A01		DE90760246	
286	15:24361	NTIS (US Sales Only), PC A04/MF A01		DE90760249	
287	15:24362	NTIS (US Sales Only), PC A04/MF A01		DE90760250	
288	15:23890	NTIS (US Sales Only), PC A04/MF A01		DE90760251	
289	15:23530	NTIS (US Sales Only), PC A04/MF A01		DE90760252	
290	15:23718	NTIS (US Sales Only), PC A03/MF A01		DE90760253	
292	15:23644	NTIS (US Sales Only), PC A04/MF A01		DE90760254	
293	15:23707	NTIS (US Sales Only), PC A03/MF A01		DE90760248	
294	15:23882	NTIS (US Sales Only), PC A03/MF A01		DE90760242	
295	15:23866	NTIS (US Sales Only), PC A03/MF A01		DE90760243	
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102	15:24163	NTIS (US Sales Only), PC A18/MF A01		DE90760265	
103	15:23820	NTIS (US Sales Only), PC A06/MF A01		DE90760285	
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1988:11	15:23504	NTIS (US Sales Only), PC A07/MF A01		DE90760286	
NIKHEF-K-AmPS–					
89-06	15:24273	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90706069	
NIKHEF-K-DIGEL–					
1989-3	15:24274	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90706072	

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1989-4	15:24322	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90706071	
1989-5	15:24308	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90706070	
NILU-F–					
9/89	15:24363	NTIS (US Sales Only), PC A02/MF A01		DE90760257	
NILU/OR–					
23/89	15:24364	NTIS (US Sales Only), PC A03/MF A01		DE90760258	
27/89	15:23821	NTIS (US Sales Only), PC A02/MF A01		DE90760260	
48/89	15:24365	NTIS (US Sales Only), PC A04/MF A01		DE90760259	
59/88	15:24160	NTIS (US Sales Only), PC A03/MF A01		DE90760287	
NOAA-TM-ERL-ARL–					
177	15:24375	*See* PB–90-142548/XAB			
179	15:24374	*See* PB–90-142217/XAB			
NOSC/TD–					
1669	15:25222	*See* AD-A–215399/7/XAB			
NRL-MR–					
6574	15:24333	*See* AD-A–215526/5/XAB			
6579	15:25115	*See* AD-A–215703/0/XAB			
NSMRL-SP–					
89-4	15:24747	*See* AD-A–215465/6/XAB			
NUREG–					
0896-Suppl.9	15:23783	NTIS, PC A08/MF A01 - GPO; OSTI; INIS		TI90008827	
NUREG/CP–					
0109	15:23784	NTIS, PC A15/MF A01 - GPO; OSTI; INIS		TI90007824	
0110	15:23785	NTIS, PC A23/MF A01 - GPO; OSTI; INIS		TI90007842	
NUREG/CR–					
4668	15:23786	NTIS, PC E10/MF E01; OSTI; INIS		TI90007705	
4691-Vol.2	15:23787	NTIS, PC A09/MF A01 - GPO; OSTI; INIS		TI90008262	
4691-Vol.3	15:23788	NTIS, PC A14/MF A01 - GPO; OSTI; INIS		TI90008263	
5289	15:23789	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI90008573	
5398	15:23586	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI90008717	
5404-Vol.1	15:23790	NTIS, PC A09/MF A01 - GPO; OSTI; INIS		TI90008726	
5511	15:23752	NTIS, PC A07/MF A01 - GPO; OSTI; INIS		TI90008264	
5527	15:23791	NTIS, PC A07/MF A01 - GPO; OSTI; INIS		TI90008681	
NUS–					
5125	15:23792	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008297	MF-528
NWTRB–					
90008658	15:23587	GPO; OSTI; U.S. Nuclear Waste Technical Review Board, 1111 18th Street N.W., Suite 801, Washington, DC 20036		TI90008658	
NYSERDA–					
90-2	15:23894	OSTI; New York State Energy Research and Development Authority, Two Rockefeller Plaza, Albany, NY 12223-9998		TI90008593	
OCS/MMS–					
90-0004	15:23458	OSTI; Office of Offshore Information and Publications, Minerals Management Service, MS642,381 Elden Street, Herndon, VA 22070-4817		TI90008594	
ORNL–					
6566/V1	15:23790	*See* NUREG/CR–5404-Vol.1			
ORNL/FEDC–					
89/1	15:25148	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008085	PC-423; PC-424
ORNL/FTR–					
3543	15:23844	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008504	
3546	15:24275	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008549	MF-414
3548	15:24717	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008550	MF-407
3551	15:24309	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008669	MF-414
3557	15:25192	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008885	MF-423
3564	15:24276	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008981	MF-414
3566	15:23937	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009011	MF-404
3572	15:23964	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008983	MF-404
ORNL/OMIS–					
90/3	15:24343	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008710	
ORNL/RASA–					
88/59	15:24393	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009012	MF-511
ORNL/TM–					
11182	15:24394	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008600	MF-511
11332	15:23588	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008268	MF-721

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11457	15:24366	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008081	MF-402
OSWER-DIRECTIVE–					
9360.0-02B	15:23825	*See* PB–90-153891/XAB			
OU/ME–					
CE02910	15:23895	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
P–					
500-89-012	15:23830	*See* CEC–90008595			
PARAMETER/IE–					
180	15:23789	*See* NUREG/CR–5289			
PATENTS-USA–					
Application7-437,401	15:25089	NTISPC N03/MF A01			
PB–					
90-121450/XAB	15:23511	NTIS, PC A07/MF A01)			
90-126434/XAB	15:23495	NTIS, PC A03/MF A01			
90-126467/XAB	15:24441	NTIS, PC A05/MF A01			
90-126475/XAB	15:24442	NTIS, PC A05/MF A01			
90-126483/XAB	15:24443	NTIS, PC A06/MF A01			
90-126491/XAB	15:24444	NTIS, PC A07/MF A01			
90-126509/XAB	15:23496	NTIS, PC A08/MF A01			
90-126517/XAB	15:24445	NTIS, PC A09/MF A01			
90-126525/XAB	15:24446	NTIS, PC A17/MF A03			
90-126533/XAB	15:24447	NTIS, PC A11/MF A02			
90-126541/XAB	15:24448	NTIS, PC A09/MF A02			
90-132432/XAB	15:24367	NTIS, PC A02/MF A01			
90-132440/XAB	15:24368	NTIS, PC A03/MF A01			
90-132457/XAB	15:24449	NTIS, PC A03/MF A01			
90-132473/XAB	15:24450	NTIS, PC A03/MF A01			
90-134164/XAB	15:24369	NTIS, PC A04/MF A01			
90-134172/XAB	15:24370	NTIS, PC A03/MF A01			
90-134180/XAB	15:24395	NTIS, PC A02/MF A01			
90-134297/XAB	15:24371	NTIS, PC A03/MF A01			
90-134362/XAB	15:24451	NTIS, PC A02/MF A01			
90-134388/XAB	15:24452	NTIS, PC A03/MF A01			
90-134412/XAB	15:24396	NTIS, PC A03/MF A01			
90-134420/XAB	15:24453	NTIS, PC A03/MF A01			
90-134438/XAB	15:24454	NTIS, PC A03/MF A01			
90-134446/XAB	15:24455	NTIS, PC A03/MF A01			
90-134453/XAB	15:24456	NTIS, PC A03/MF A01			
90-134479/XAB	15:24457	NTIS, PC A03/MF A01			
90-135203/XAB	15:24750	NTIS, PC A02/MF A01			
90-135245/XAB	15:24751	NTIS, PC A03/MF A01			
90-135260/XAB	15:24397	NTIS, PC A03/MF A01			
90-135278/XAB	15:24372	NTIS, PC A02/MF A01			
90-135435/XAB	15:23380	NTIS, PC A03/MF A01			
90-135492/XAB	15:24398	NTIS, PC A03/MF A01			
90-135724/XAB	15:25149	NTIS, PC A03/MF A01			
90-135971/XAB	15:24458	NTIS, PC A03/MF A01			
90-135989/XAB	15:24459	NTIS, PC A02/MF A01			
90-135997/XAB	15:24460	NTIS, PC A03/MF A01			
90-136003/XAB	15:24461	NTIS, PC A02/MF A01			
90-136011/XAB	15:24462	NTIS, PC A02/MF A01			
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90-136037/XAB	15:24463	NTIS, PC A03/MF A01			
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90-136086/XAB	15:24467	NTIS, PC A03/MF A01			
90-136094/XAB	15:24468	NTIS, PC A02/MF A01			
90-136102/XAB	15:24401	NTIS, PC A02/MF A01			
90-136110/XAB	15:24469	NTIS, PC A03/MF A01			
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90-136144/XAB	15:24373	NTIS, PC A02/MF A01			
90-136151/XAB	15:24471	NTIS, PC A03/MF A01			
90-136169/XAB	15:23497	NTIS, PC A02/MF A01			
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90-136219/XAB	15:24474	NTIS, PC A03/MF A01			
90-136227/XAB	15:24475	NTIS, PC A03/MF A01			
90-136235/XAB	15:24476	NTIS, PC A03/MF A01			
90-136243/XAB	15:24477	NTIS, PC A02/MF A01			
90-136250/XAB	15:24478	NTIS, PC A03/MF A01			
90-136268/XAB	15:24479	NTIS, PC A03/MF A01			
90-137001/XAB	15:23658	NTIS, PC A05/MF A01			
90-137043/XAB	15:24480	NTIS, PC A02/MF A01			
90-137068/XAB	15:24481	NTIS, PC A03/MF A01			
90-137316/XAB	15:24482	NTIS, PC A10/MF A02			
90-137324/XAB	15:24483	NTIS, PC A10/MF A02			
90-137332/XAB	15:24484	NTIS, PC A03/MF A01			
90-137340/XAB	15:24485	NTIS, PC A03/MF A01			
90-137795/XAB	15:24486	NTIS, PC A02/MF A01			
90-137803/XAB	15:24487	NTIS, PC A03/MF A01			
90-137811/XAB	15:24488	NTIS, PC A02/MF A01			
90-137829/XAB	15:24489	NTIS, PC A03/MF A01			
90-137837/XAB	15:24490	NTIS, PC A03/MF A01			
90-137845/XAB	15:24491	NTIS, PC A03/MF A01			
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90-137860/XAB	15:24493	NTIS, PC A03/MF A01			
90-137878/XAB	15:24494	NTIS, PC A02/MF A01			
90-137886/XAB	15:24495	NTIS, PC A02/MF A01			
90-137894/XAB	15:24496	NTIS, PC A03/MF A01			
90-137902/XAB	15:24497	NTIS, PC A03/MF A01			
90-137910/XAB	15:24498	NTIS, PC A02/MF A01			
90-137928/XAB	15:24499	NTIS, PC A03/MF A01			
90-137936/XAB	15:24500	NTIS, PC A02/MF A01			
90-137944/XAB	15:24501	NTIS, PC A03/MF A01			
90-137951/XAB	15:24502	NTIS, PC A02/MF A01			
90-137969/XAB	15:23381	NTIS, PC A02/MF A01			
90-137985/XAB	15:24503	NTIS, PC A03/MF A01			
90-137993/XAB	15:24504	NTIS, PC A04/MF A01			
90-138009/XAB	15:24505	NTIS, PC A02/MF A01			
90-138017/XAB	15:24506	NTIS, PC A02/MF A01			
90-138025/XAB	15:23498	NTIS, PC A03/MF A01			
90-138033/XAB	15:24507	NTIS, PC A02/MF A01			
90-138041/XAB	15:24508	NTIS, PC A02/MF A01			
90-138314/XAB	15:24509	NTIS, PC A06/MF A01			
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90-138348/XAB	15:24512	NTIS, PC A05/MF A01			
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90-138363/XAB	15:24513	NTIS, PC A05/MF A01			
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90-138397/XAB	15:24515	NTIS, PC A05/MF A01			
90-138405/XAB	15:24516	NTIS, PC A06/MF A01			
90-138447/XAB	15:24517	NTIS, PC A02/MF A01			
90-138454/XAB	15:24518	NTIS, PC A03/MF A01			
90-138637/XAB	15:24519	NTIS, PC A07/MF A01			
90-138744/XAB	15:23822	NTIS, PC A08/MF A01			
90-140468/XAB	15:24520	NTIS, PC A02/MF A01			
90-140476/XAB	15:24521	NTIS, PC A02/MF A01			
90-140484/XAB	15:24522	NTIS, PC A02/MF A01			
90-140492/XAB	15:24523	NTIS, PC A02/MF A01			
90-140500/XAB	15:24524	NTIS, PC A03/MF A01			
90-140518/XAB	15:24525	NTIS, PC A03/MF A01			
90-140534/XAB	15:24526	NTIS, PC A02/MF A01			
90-140542/XAB	15:24527	NTIS, PC A02/MF A01			
90-140559/XAB	15:24528	NTIS, PC A03/MF A01			
90-140567/XAB	15:24529	NTIS, PC A03/MF A01			
90-140575/XAB	15:24530	NTIS, PC A02/MF A01			
90-140583/XAB	15:24531	NTIS, PC A03/MF A01			
90-140591/XAB	15:24532	NTIS, PC A02/MF A01			
90-140609/XAB	15:23499	NTIS, PC A02/MF A01			
90-140617/XAB	15:24533	NTIS, PC A02/MF A01			
90-140625/XAB	15:24534	NTIS, PC A02/MF A01			
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90-140708/XAB	15:24539	NTIS, PC A03/MF A01			
90-140732/XAB	15:24754	NTIS, PC A02/MF A01			
90-140757/XAB	15:23719	NTIS, PC A02/MF A01			
90-140781/XAB	15:23668	NTIS, PC A02/MF A01			
90-140799/XAB	15:24755	NTIS, PC A02/MF A01			
90-140823/XAB	15:23669	NTIS, PC A02/MF A01			
90-140831/XAB	15:24756	NTIS, PC A03/MF A01			
90-140849/XAB	15:24757	NTIS, PC A02/MF A01			
90-140898/XAB	15:24540	NTIS, PC A02/MF A01			
90-141003/XAB	15:24541	NTIS, PC A03/MF A01			
90-141219/XAB	15:23351	NTIS, PC EE04/MF E04			
90-141243/XAB	15:24727	NTIS, PC A06/MF A01			
90-141417/XAB	15:24542	NTIS, PC A02/MF A01			
90-141433/XAB	15:24543	NTIS, PC A03/MF A01			
90-141441/XAB	15:24544	NTIS, PC A02/MF A01			
90-141458/XAB	15:23500	NTIS, PC A02/MF A01			
90-141466/XAB	15:24402	NTIS, PC A02/MF A01			
90-141474/XAB	15:23501	NTIS, PC A03/MF A01			
90-141482/XAB	15:24545	NTIS, PC A03/MF A01			
90-141490/XAB	15:24546	NTIS, PC A02/MF A01			
90-141508/XAB	15:24547	NTIS, PC A03/MF A01			
90-141516/XAB	15:24548	NTIS, PC A02/MF A01			
90-141524/XAB	15:24403	NTIS, PC A03/MF A01			
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90-141623/XAB	15:24556	NTIS, PC A02/MF A01			
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90-141961/XAB	15:24583	NTIS, PC A02/MF A01			
90-141979/XAB	15:24584	NTIS, PC A03/MF A01			
90-141987/XAB	15:24585	NTIS, PC A03/MF A01			
90-141995/XAB	15:24586	NTIS, PC A02/MF A01			
90-142001/XAB	15:24587	NTIS, PC A02/MF A01			
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90-142035/XAB	15:24589	NTIS, PC A02/MF A01			
90-142043/XAB	15:24590	NTIS, PC A02/MF A01			
90-142084/XAB	15:24591	NTIS, PC A02/MF A01			
90-142100/XAB	15:24592	NTIS, PC A02/MF A01			

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90-142118/XAB	15:24593	NTIS, PC A02/MF A01			
90-142126/XAB	15:24594	NTIS, PC A02/MF A01			
90-142142/XAB	15:24595	NTIS, PC A02/MF A01			
90-142217/XAB	15:24374	NTIS, PC A03/MF A01			
90-142324/XAB	15:24144	NTIS, PC A11/MF A02			
90-142357/XAB	15:24758	NTIS, PC A04/MF A01			
90-142373/XAB	15:24759	NTIS, PC A03/MF A01			
90-142381/XAB	15:24760	NTIS, PC A04/MF A01			
90-142399/XAB	15:24761	NTIS, PC A04/MF A01			
90-142449/XAB	15:24762	NTIS, PC A04/MF A01			
90-142464/XAB	15:24763	NTIS, PC A03/MF A01			
90-142472/XAB	15:24764	NTIS, PC A03/MF A01			
90-142480/XAB	15:24765	NTIS, PC A04/MF A01			
90-142498/XAB	15:24766	NTIS, PC A05/MF A01			
90-142506/XAB	15:24767	NTIS, PC A04/MF A01			
90-142514/XAB	15:24768	NTIS, PC A03/MF A01			
90-142548/XAB	15:24375	NTIS, PC A04/MF A01			
90-142571/XAB	15:24769	NTIS, PC A03/MF A01			
90-142902/XAB	15:24596	NTIS, PC A02/MF A01			
90-142928/XAB	15:23722	NTIS, PC A02/MF A01			
90-143553/XAB	15:24597	NTIS, PC A03/MF A01			
90-143561/XAB	15:23383	NTIS, PC A02/MF A01			
90-143579/XAB	15:24598	NTIS, PC A02/MF A01			
90-143587/XAB	15:24599	NTIS, PC A02/MF A01			
90-143595/XAB	15:24600	NTIS, PC A02/MF A01			
90-143603/XAB	15:23384	NTIS, PC A02/MF A01			
90-143611/XAB	15:23502	NTIS, PC A03/MF A01			
90-143629/XAB	15:24601	NTIS, PC A02/MF A01			
90-143637/XAB	15:23385	NTIS, PC A02/MF A01			
90-143645/XAB	15:24602	NTIS, PC A03/MF A01			
90-143652/XAB	15:24603	NTIS, PC A02/MF A01			
90-143660/XAB	15:24604	NTIS, PC A03/MF A01			
90-143686/XAB	15:24605	NTIS, PC A02/MF A01			
90-143694/XAB	15:24606	NTIS, PC A03/MF A01			
90-143702/XAB	15:24607	NTIS, PC A02/MF A01			
90-143710/XAB	15:24608	NTIS, PC A02/MF A01			
90-143728/XAB	15:23386	NTIS, PC A02/MF A01			
90-143736/XAB	15:24609	NTIS, PC A02/MF A01			
90-143744/XAB	15:24610	NTIS, PC A03/MF A01			
90-143751/XAB	15:24611	NTIS, PC A03/MF A01			
90-143769/XAB	15:24612	NTIS, PC A03/MF A01			
90-143777/XAB	15:24613	NTIS, PC A03/MF A01			
90-143785/XAB	15:24614	NTIS, PC A02/MF A01			
90-143793/XAB	15:24615	NTIS, PC A02/MF A01			
90-143801/XAB	15:24406	NTIS, PC A02/MF A01			
90-143819/XAB	15:24616	NTIS, PC A03/MF A01			
90-143835/XAB	15:24617	NTIS, PC A03/MF A01			
90-143843/XAB	15:24618	NTIS, PC A02/MF A01			
90-143868/XAB	15:24619	NTIS, PC A02/MF A01			
90-143876/XAB	15:24620	NTIS, PC A02/MF A01			
90-143884/XAB	15:24621	NTIS, PC A02/MF A01			
90-143892/XAB	15:24622	NTIS, PC A02/MF A01			
90-143900/XAB	15:24623	NTIS, PC A02/MF A01			
90-143918/XAB	15:24376	NTIS, PC A03/MF A01			
90-143926/XAB	15:23387	NTIS, PC A02/MF A01			
90-143942/XAB	15:24624	NTIS, PC A02/MF A01			
90-143959/XAB	15:24625	NTIS, PC A03/MF A01			
90-143967/XAB	15:24626	NTIS, PC A03/MF A01			
90-143975/XAB	15:24627	NTIS, PC A02/MF A01			
90-143983/XAB	15:24628	NTIS, PC A02/MF A01			
90-144007/XAB	15:24629	NTIS, PC A02/MF A01			
90-144015/XAB	15:24630	NTIS, PC A03/MF A01			
90-144023/XAB	15:24631	NTIS, PC A03/MF A01			
90-144031/XAB	15:24632	NTIS, PC A02/MF A01			
90-144049/XAB	15:24633	NTIS, PC A03/MF A01			
90-144056/XAB	15:24634	NTIS, PC A02/MF A01			
90-144064/XAB	15:24635	NTIS, PC A02/MF A01			
90-144072/XAB	15:24636	NTIS, PC A02/MF A01			
90-144080/XAB	15:24637	NTIS, PC A02/MF A01			
90-144098/XAB	15:24638	NTIS, PC A02/MF A01			
90-144106/XAB	15:23388	NTIS, PC A03/MF A01			

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90-144114/XAB	15:24639	NTIS, PC A02/MF A01			
90-144122/XAB	15:24377	NTIS, PC A02/MF A01			
90-144130/XAB	15:24640	NTIS, PC A03/MF A01			
90-144148/XAB	15:23389	NTIS, PC A02/MF A01			
90-144155/XAB	15:24641	NTIS, PC A02/MF A01			
90-144163/XAB	15:24642	NTIS, PC A03/MF A01			
90-144171/XAB	15:24643	NTIS, PC A03/MF A01			
90-144189/XAB	15:24644	NTIS, PC A02/MF A01			
90-144197/XAB	15:24407	NTIS, PC A02/MF A01			
90-144205/XAB	15:24645	NTIS, PC A03/MF A01			
90-144213/XAB	15:24646	NTIS, PC A02/MF A01			
90-144221/XAB	15:24647	NTIS, PC A02/MF A01			
90-144239/XAB	15:24648	NTIS, PC A02/MF A01			
90-144247/XAB	15:24649	NTIS, PC A02/MF A01			
90-144254/XAB	15:24650	NTIS, PC A03/MF A01			
90-144262/XAB	15:24651	NTIS, PC A02/MF A01			
90-144270/XAB	15:24652	NTIS, PC A02/MF A01			
90-144288/XAB	15:24653	NTIS, PC A02/MF A01			
90-144296/XAB	15:24654	NTIS, PC A03/MF A01			
90-144304/XAB	15:24655	NTIS, PC A03/MF A01			
90-144320/XAB	15:24656	NTIS, PC A02/MF A01			
90-144338/XAB	15:24657	NTIS, PC A02/MF A01			
90-144346/XAB	15:24658	NTIS, PC A03/MF A01			
90-144353/XAB	15:24659	NTIS, PC A02/MF A01			
90-144361/XAB	15:24660	NTIS, PC A02/MF A01			
90-144379/XAB	15:24661	NTIS, PC A02/MF A01			
90-144387/XAB	15:24662	NTIS, PC A03/MF A01			
90-144395/XAB	15:24663	NTIS, PC A02/MF A01			
90-144403/XAB	15:24664	NTIS, PC A02/MF A01			
90-144411/XAB	15:24665	NTIS, PC A02/MF A01			
90-144437/XAB	15:24666	NTIS, PC A02/MF A01			
90-144445/XAB	15:24667	NTIS, PC A03/MF A01			
90-144452/XAB	15:24668	NTIS, PC A02/MF A01			
90-144460/XAB	15:24669	NTIS, PC A02/MF A01			
90-144478/XAB	15:24378	NTIS, PC A02/MF A01			
90-144486/XAB	15:24670	NTIS, PC A02/MF A01			
90-144494/XAB	15:24671	NTIS, PC A02/MF A01			
90-144502/XAB	15:24672	NTIS, PC A02/MF A01			
90-144510/XAB	15:24673	NTIS, PC A02/MF A01			
90-144528/XAB	15:24674	NTIS, PC A03/MF A01			
90-144536/XAB	15:24675	NTIS, PC A02/MF A01			
90-144551/XAB	15:24676	NTIS, PC A03/MF A01			
90-144569/XAB	15:24677	NTIS, PC A02/MF A01			
90-144577/XAB	15:23528	NTIS, PC A03/MF A01			
90-144585/XAB	15:24678	NTIS, PC A02/MF A01			
90-144593/XAB	15:24679	NTIS, PC A03/MF A01			
90-144619/XAB	15:24680	NTIS, PC A02/MF A01			
90-144627/XAB	15:24681	NTIS, PC A02/MF A01			
90-144635/XAB	15:24682	NTIS, PC A02/MF A01			
90-144643/XAB	15:24683	NTIS, PC A02/MF A01			
90-144650/XAB	15:24684	NTIS, PC A03/MF A01			
90-144668/XAB	15:24685	NTIS, PC A02/MF A01			
90-144676/XAB	15:24686	NTIS, PC A03/MF A01			
90-144692/XAB	15:24408	NTIS, PC A03/MF A01			
90-144700/XAB	15:24687	NTIS, PC A02/MF A01			
90-144718/XAB	15:24688	NTIS, PC A02/MF A01			
90-144726/XAB	15:24689	NTIS, PC A03/MF A01			
90-144734/XAB	15:24690	NTIS, PC A02/MF A01			
90-144742/XAB	15:24691	NTIS, PC A02/MF A01			
90-144759/XAB	15:24692	NTIS, PC A02/MF A01			
90-144767/XAB	15:24693	NTIS, PC A02/MF A01			
90-144775/XAB	15:24694	NTIS, PC A02/MF A01			
90-144783/XAB	15:24695	NTIS, PC A02/MF A01			
90-144791/XAB	15:23390	NTIS, PC A02/MF A01			
90-144809/XAB	15:24409	NTIS, PC A02/MF A01			
90-144817/XAB	15:24696	NTIS, PC A02/MF A01			
90-144825/XAB	15:24697	NTIS, PC A02/MF A01			
90-144833/XAB	15:24698	NTIS, PC A02/MF A01			
90-144841/XAB	15:24699	NTIS, PC A03/MF A01			
90-145012/XAB	15:24728	NTIS, PC A02/MF A01			
90-145798/XAB	15:23503	NTIS, PC A02/MF A01			

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90-145988/XAB	15:24729	NTIS, PC A02/MF A01			
90-146069/XAB	15:24770	NTIS, PC A03/MF A01			
90-146127/XAB	15:24771	NTIS, PC A02/MF A01			
90-146408/XAB	15:23524	NTIS, PC A14/MF A02			
90-146606/XAB	15:24772	NTIS, PC A02/MF A01			
90-146788/XAB	15:23834	NTIS, PC A02/MF A01			
90-146796/XAB	15:23835	NTIS, PC A02/MF A01			
90-146804/XAB	15:23836	NTIS, PC A03/MF A01			
90-146861/XAB	15:24327	NTIS, PC A03/MF A01			
90-147554/XAB	15:23411	NTIS, PC A12/MF A02			
90-148065/XAB	15:23852	NTIS, PC A03/MF A01			
90-148081/XAB	15:23867	NTIS, PC A01/MF A01			
90-148263/XAB	15:23405	NTIS, PC A06/MF A01			
90-148271/XAB	15:23391	NTIS, PC A03/MF A01			
90-148313/XAB	15:23826	NTIS, PC A09/MF A01			
90-148743/XAB	15:23392	NTIS, PC A04/MF A01			
90-150582/XAB	15:23827	NTIS, PC A08			
90-151028/XAB	15:23393	NTIS, PC A03/MF A01			
90-151077/XAB	15:23406	NTIS, PC A04/MF A01			
90-153875/XAB	15:23823	NTIS, PC A09/MF A01			
90-153883/XAB	15:23824	NTIS, PC A08/MF A01			
90-153891/XAB	15:23825	NTIS, PC A10/MF A02			
90-856220/XAB	15:24773	NTISPC N01/MF N01			
90-856329/XAB	15:24774	NTISPC N01/MF N01			
90-856436/XAB	15:24775	NTISPC N01/MF N01			
90-856618/XAB	15:24776	NTISPC N01/MF N01			
90-856857/XAB	15:24777	NTISPC N01/MF N01			
90-857269/XAB	15:24784	NTISPC N01/MF N01			
90-857285/XAB	15:24785	NTISPC N01/MF N01			
90-857392/XAB	15:23883	NTISPC N01/MF N01			
90-857400/XAB	15:23884	NTISPC N01/MF N01			
90-857723/XAB	15:24379	NTISPC N01/MF N01			
90-858069/XAB	15:24817	NTISPC N01/MF N01			
90-858135/XAB	15:23988	NTISPC N01/MF N01			
90-858168/XAB	15:23885	NTISPC N01/MF N01			
90-858192/XAB	15:23891	NTISPC N01/MF N01			
90-920999/XAB	15:24730	NTISStanding Order			
PCMWP-DDTF/P–					
118	15:24141	*See* AWE–44/99/5			
PEP-NOTE–					
381	15:24277	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008580	MF-414
PIRSEM–					
3256	15:23651	NTIS (US Sales Only), PC A05/MF A01		DE90761950	
PNL–					
7142	15:23589	NTIS, PC A10/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007915	MF-721
7273	15:23590	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007914	MF-510
7280	15:23591	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008802	MF-801
PNL-SA–					
16909	15:24380	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008607	MF-603
16981	15:25193	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008621	MF-420
17037	15:24736	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008629	MF-507
17157	15:23592	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008630	MF-814
17194	15:23593	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008619	MF-512
17226	15:23965	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008633	MF-404
17242	15:23594	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008628	MF-721
17266	15:25252	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008604	MF-500
17271	15:23966	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008599	MF-404
17282	15:23623	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008606	MF-602
17283	15:23618	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008622	MF-510
17284	15:23595	NTIS, PC A03/MF A01; OSTI; INIS		DE90008605	MF-512
17285	15:23596	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008617	MF-511
17289	15:24700	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008625	MF-502
17319	15:23597	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008632	MF-814
17336	15:23624	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008609	MF-510
17339	15:23797	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008616	MF-920
17399	15:23833	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008610	MF-400
17450	15:23967	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008627	MF-504
17633	15:23598	NTIS, PC A10/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008626	MF-510; MF-502
17690	15:23599	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008631	MF-721
17727	15:23541	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008614	MF-812

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PNL-SA–					
17794	15:23793	NTIS, PC A02/MF A01 - OSTI		DE90008618	MF-721
17851	15:23868	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008608	MF-408
PPA-AR–					
13.1	15:25213	NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS		DE90622162	
13.3	15:25214	NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS		DE90622163	
13.4	15:25215	NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS		DE90622164	
19.2	15:25216	NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS		DE90622155	
3.2	15:25212	NTIS (US Sales Only), PC A12/MF A01; OSTI; INIS		DE90622165	
PPPL–					
2676	15:25150	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008152	PC-426
2679	15:25151	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007943	PC-420; PC-426
PPPL-Q–					
46	15:25194	NTIS, PC A08/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008662	MF-420
RAL–					
89-114	15:24931	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620870	
89-115	15:24973	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620481	
89-118	15:24278	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90621885	
89-120	15:24279	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90621886	
RAND/R–					
3765-AF	15:23897	*See* AD-A-215606/5/XAB			
RFP–					
4409	15:24381	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008861	MF-700
RISO-M–					
2817	15:23708	NTIS (US Sales Only), PC A03/MF A01		DE90760176	
2819	15:23460	NTIS (US Sales Only), PC A04/MF A01		DE90760177	
2827	15:23688	NTIS (US Sales Only), PC A03/MF A01		DE90760178	
2828	15:23689	NTIS (US Sales Only), PC A03/MF A01		DE90760179	
2829	15:23690	NTIS (US Sales Only), PC A03/MF A01		DE90760180	
RR–					
54	15:24043	Available from the Registrar, University of Pretoria, Pretoria, 0002, South Africa			
RIInconsult–					
1983	15:23600	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90706073	
S-HRG–					
101-377	15:24382	Subcommittee on the Consumer, Senate, Washington, D.C. 20510 HC free; SOD HC $3.25 as 552-070-07449-0			
SA-SR–					
12	15:24828	*See* N–90-15025			
SAIC–					
88/1638	15:23411	*See* PB–90-147554/XAB			
88/1956	15:25121	*See* DOE/SF/15935–T1			
SAND–					
0494C	15:24315	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008727	MF-700
86-1030	15:23786	*See* NUREG/CR–4668			
86-1397	15:24186	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007901	MF-906
86-1562-Vol.2	15:23787	*See* NUREG/CR–4691-Vol.2			
86-1562-Vol.3	15:23788	*See* NUREG/CR–4691-Vol.3			
87-1734	15:24334	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007902	MF-906
88-0714	15:24145	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008157	PC-722
88-1387	15:23601	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008164	MF-814
88-3291	15:25240	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008163	MF-405
89-0412C	15:24148	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008503	MF-706
89-0926/1	15:23625	NTIS, PC A16/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008574	MF-700
89-0926/2	15:23626	NTIS, PC A21/MF A01 - OSTI		DE90008160	MF-700
89-1557	15:23586	*See* NUREG/CR–5398			
89-2097C	15:25241	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007455	MF-706
89-2176C	15:23603	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007501	MF-721
89-2378C	15:23604	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007561	
89-2534	15:24344	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008166	MF-705

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89-2580C	15:24331	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008509	MF-706
89-2600	15:23627	NTIS, PC A05/MF A01 - OSTI		DE90008168	MF-700
89-2690	15:23628	NTIS, PC A03/MF A01 - OSTI		DE90008167	MF-700
89-2781	15:25242	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008165	MF-405
89-2783C	15:25253	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008529	MF-706
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